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A Profile of Advanced Manufacturing in the Northeast Region: Key Industry and Occupational Trends

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Executive Summary

This report provides a detailed examination of Advanced Manufacturing in the Northeast region. This report is part of an eight-part series, each focusing on different areas of the Commonwealth. It examines recent employment and earnings trends; analyzes key occupations in Advanced Manufacturing's subsectors, looking for common labor needs and comparing wages to similar workers in other industries; identifies the most common and critical skills needed by employers; and offers a detailed demographic profile of Advanced Manufacturing to highlight areas of critical concern for the future health of the industry.

More people in the Northeast work in Advanced Manufacturing than in any other region. The region's nearly 65,000 workers account for nearly a third of all Advanced Manufacturing employment in the Commonwealth. Annual earnings top $89,000 per worker—greatly exceeding the state average as well as most other major industry sectors in the Northeast. The depth of the Advanced Manufacturing sector in the region is reflected in a labor pool which is both deep and broad, with a wide spectrum of workers to draw from of various skill and education levels. In particular, there is a core group of workers that support research and innovative activities in addition to those more focused on production and operations.

The Northeast region is dominated by the Computer and Electronics products subsector. Its 370 individual business establishments employ more than 26,000 workers, accounting for over 41% of the entire Advanced Manufacturing employment base. Wages in Computers and Electronics top $115,000 per year with robust real wage growth over the past decade However, the region's dependence on Computers and Electronics is also a liability. The subsector has shed a net 21,000 jobs since 2001—the largest total loss of any subsector in any region of the state and 60 percent of all job losses in the region's Advanced Manufacturing sector during this period.

The Advanced Manufacturing workforce in the Northeast is one of the most highly educated and experienced in the state. But like most other areas, the Northeast region may also soon be facing an acute labor shortage if action is not taken in the near future. The typical Advanced Manufacturing worker is currently 45 years old, and within the next ten years roughly 20 percent of the region's Advanced Manufacturing workforce will approach or enter the traditional retirement age. There are presently few younger workers in the pipeline to replace the impeding retirees. But with proper training and outreach, these anticipated retirements may also create opportunities for young workers and others having a hard time finding a path to well-paying jobs in the modern economy.

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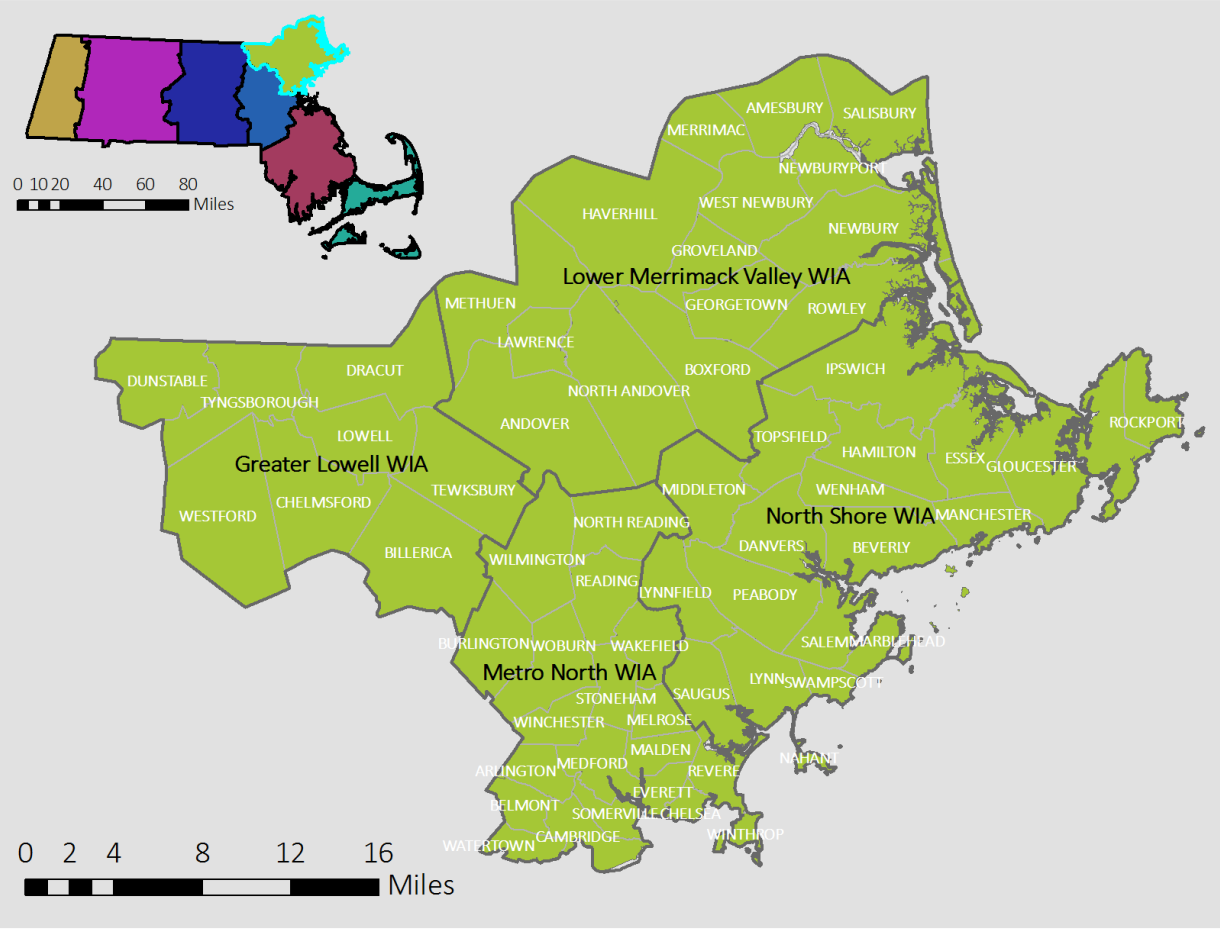
Introduction

Study Purpose and Scope

This report provides a detailed examination of the industrial ecology and occupational composition of Advanced Manufacturing in the Northeast Region (Figure 1). Its purpose is to provide up-to-date and actionable information to help guide policy and program decisions directed to securing a strong future for the region's Manufacturing sector. The industry definitions of the Advanced Manufacturing sector are provided in Appendix A. A more in-depth discussion on the rationale behind these definitions is provided in the state-level companion report titled "A Profile of Advanced Manufacturing in the Commonwealth: Key Industry and Occupational Trends."

This report is one of seven regional profiles of the Advance Manufacturing sector (Appendix B). While this report is designed to stand alone, we highly encourage readers to also examine the state-level profile, which

Figure 1
The Northeast Region



provides additional detail on definitions, methods and data sources; as well as comparisons across all of the seven designated regional labor markets. This report focuses on industry and occupational trends within the Northeast region, making reference to other regions or the state for the sake of comparison

This report follows a similar template and format as the state-level study, and is based on an analysis of common public data sources. It opens with a review of recent industrial trends—employment, wages and salaries—as well as a discussion of the impact of the recent recession and recovery.

Next, we move on to a detailed examination of the most prominent and specialized (i.e. "core") occupations in the Advanced Manufacturing sector and its component subsectors. We also consider crossover occupations that are prevalent in multiple industries within Advanced Manufacturing, which provide likely targets for training programs that offer the greatest benefit to the most employers. This is followed by an analysis of the specific types of skills that are used and required by these core occupations. Skills transcend both occupations and industries, and thus regrouping occupations in terms of complimentary and similar skills provides another venue for identifying possible targets for training and other development programs.

This report closes with a detailed demographic profile of the people that work in Advanced Manufacturing in the Northeast region. We pay particular attention to areas of critical concern for the future health of the industry, such as the aging of the workforce, the gender gap, commuting patterns, educational attainment, and the prevalence of foreign born workers. Our demographic profile uses similar data sources and many common metrics covered by the recent regional labor force profiles of the Federal Reserve Bank of Boston[1]. It differs in that our analysis focuses solely on the Advanced Manufacturing workforce, while the Fed profiles focus on the entirety of the labor market with only limited coverage of workers in specific industries.

[1] The report and interactive data viewer for the Federal Reserve Bank of Boston labor market profiles can be viewed at http://www.bostonfed.org/economic/neppc/labor-market-trends-in-massachusetts-regions/

Industry Trends in the Northeast Region

Advanced Manufacturing is a crucial component of the Northeast regional economy. The Northeast is home to more Advanced Manufacturing workers and businesses than any other region in the state. As of 2012, there were just under 1,600 establishments and 64,000 employees in the Northeast region's Advanced Manufacturing sector, representing roughly 8 percent of the region's total employment base and nearly 32 percent of all Manufacturing employment statewide (Table 1 and Figure 1). It's share of Advanced Manufacturing employment exceeds both state and national averages, followed only by the Central region in terms of the concentration of Advanced Manufacturing employment relative to the overall size of the region's economy (Figure 2).

Table 1
Employment, Establishment, and Earnings Summary by Major Industry Sectors, 2012

	Establishments			Employment			Real Wage and Salary Earnings*	
Sector	Number	Change from 2001	Average Size	Number	Change from 2001	Location Quotient	per Worker	Change from 2001
Advanced Manufacturing	1,590	-536	40.2	63,842	-34,155	1.30	$89,969	$11,330
Other Manufacturing	420	-211	44.3	18,622	-6,243	0.78	$88,392	$14,649
Natural Resources and Mining	160	-59	5.0	802	-983	0.07	$32,872	-$16,062
Construction	4,703	237	7.0	33,023	-8,176	0.94	$64,251	-$4,336
Trade, Transportation and Utilities	9,414	-674	15.0	141,283	-16,469	0.87	$45,659	-$5,283
Information	1,103	-202	25.1	27,714	-7,898	1.61	$105,629	$12,550
Financial Activities	3,548	107	9.4	33,519	-1,256	0.72	$77,365	$11,260
Professional and Business Services	9,971	814	14.1	140,162	870	1.27	$95,756	$17,773
Education and Health Services	5,253	630	39.6	207,947	33,440	1.11	$55,406	$6,193
Leisure and Hospitality	4,855	663	15.5	75,204	9,915	0.87	$20,266	-$1,727
Other Services	9,759	4,187	3.4	33,217	6,869	1.19	$29,600	-$3,531
Public Administration	678	121	40.1	27,215	-287	0.61	$62,277	$4,844
Total, all industries	51,471	5,094	15.6	803,607	-23,315	1.00	$63,141	$3,351

*Measured in 2013 dollars

Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's Calculations

There are signs that that Northeast's Advanced Manufacturing sector is beginning to emerge from long-term trends of decline. The region's Advanced Manufacturing sector shed just over 500 establishments and 34,000 jobs between 2001 and 2012—representing just over a quarter of the region's 2001 employment base (Figure 3). This is the largest number of job losses of any region in the state, although the impacts of losses were felt more strongly in the Berkshires and the Central region relative to their size. As we will show later, these losses were particularly concentrated in the region's computers and electronics subsector.

The good news is that employment seems to have leveled-off in recent years. The job losses of the past twelve years were heavily concentrated in the early years of the millennia, which hit the region's Computer and Electronics subsector particularly hard (Figure 4). The region's Advanced Manufacturing sector lost nearly 15,000 jobs between 2001 and 2002 — by far the greatest single year loss of the entire study period. The sector continued its downward slide, albeit at an diminishing pace, until mid-decade. Between 2006 and 2007 the sector actually added nearly 2,000 new workers to its payrolls. However, this rebound was cut short by the Great Recession. At the peak of the recession between 2008 and 2009, the Advanced Manufacturing sector experienced a single year decline of nearly 7,000 jobs and 50 businesses. The industry has essentially held steady since 2010.

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Figure 2
Regional Distribution of Advanced Manufacturing Employment

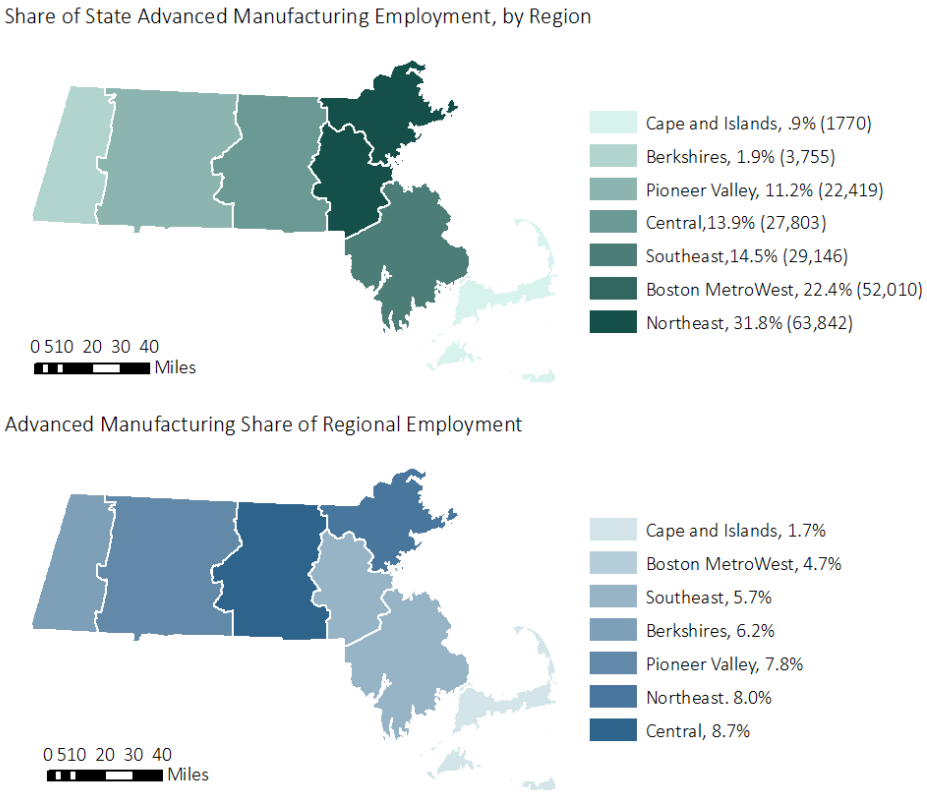
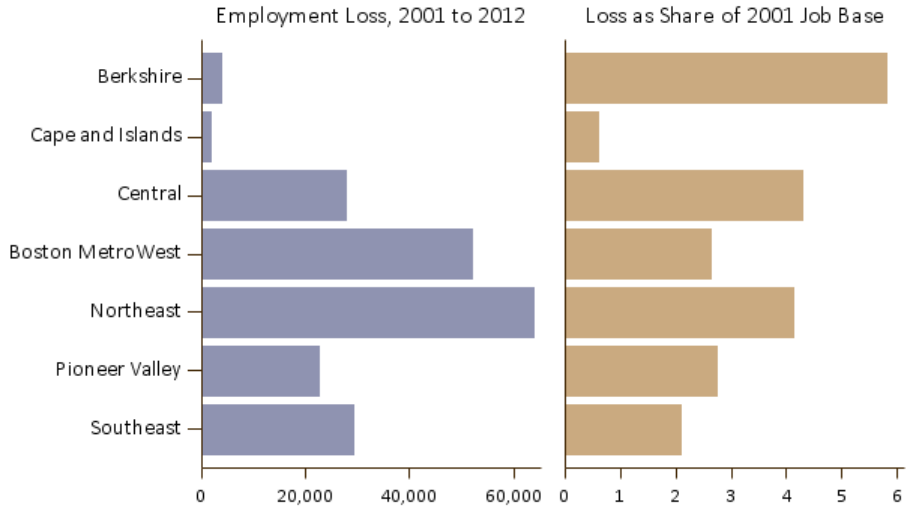


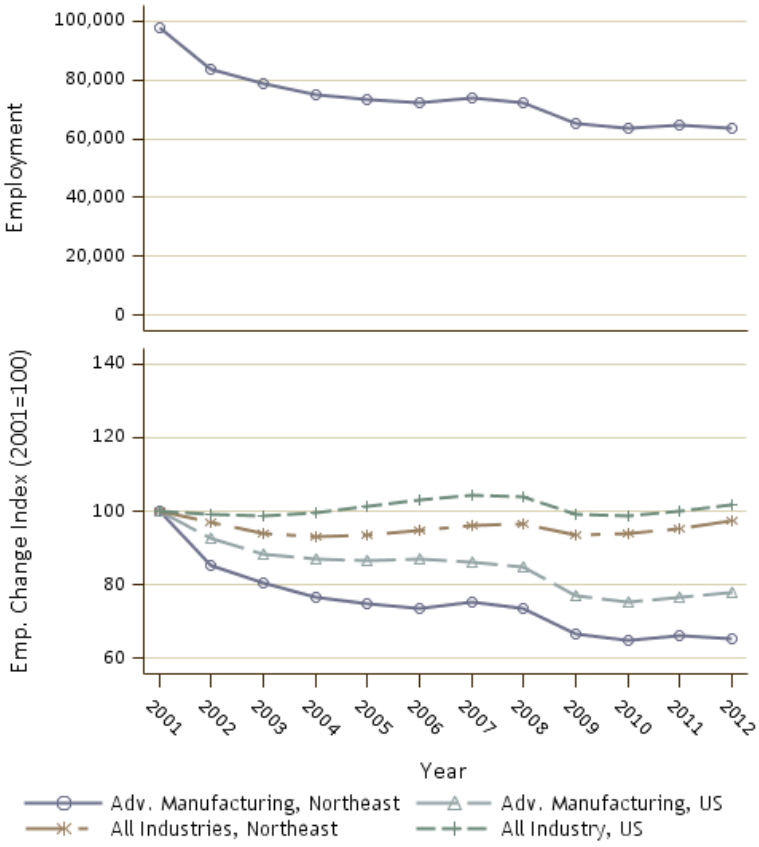
Figure 3
Regional Distribution of Job Losses in Advanced Manufacturing



Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

compares employment trends in the Northeast region's Advanced Manufacturing sector against the nation. The 2001 recession had a noticeably deeper and more prolonged impact on the Northeast region than the US economy as a whole—particularly in the Advanced Manufacturing sector. The overall regional economy did weather the 2008 recession slightly better than the overall U.S. economy, and has shown more robust growth during the recovery. But the region still lags the nation in the Advanced Manufacturing sector, which has shown two years of slow, but steady growth since 2010, while the region has remained relatively flat.

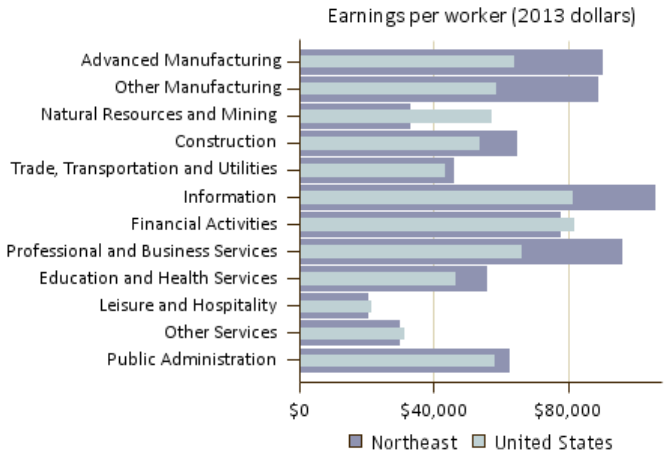
Figure 4
Annual employment change in Advanced Manufacturing, 2001 to 2012



Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

Although it may lag the nation in terms of job growth, the Northeast region is clearly surpassing the nation in terms of earnings. On average, workers in the region's Advanced Manufacturing sector earn nearly $30,000 more a year than their national counterparts (Figure 5). Within Massachusetts, only the Boston / MetroWest region pays a higher average wage. These relatively high earnings are due, in part, to the region's heavy concentration in Computers and Electronics —the highest paying subsector in Advanced Manufacturing (Figure 5). Wage growth in Massachusetts' Advanced Manufacturing sector has also surpassed the nation for most of the past decade (Figure 6).

Figure 5
Average Earnings per Worker (2012),
Northeast Region compared to the Nation

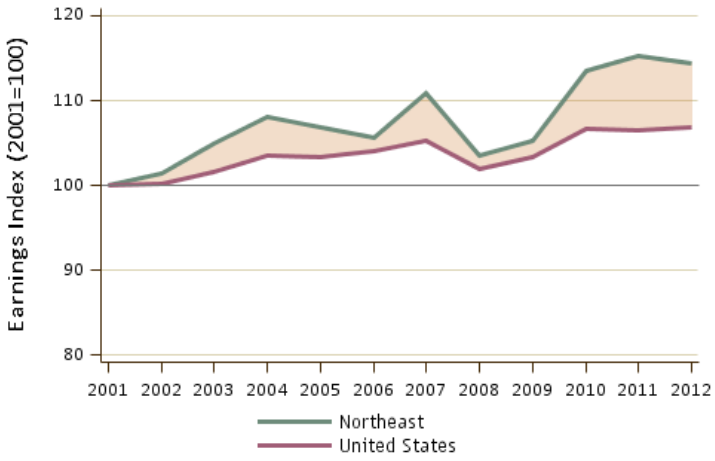


Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

The primary exception is during the Great Recession of 2008-09 where average earnings temporarily declined and nearly converge to the national average. Wages quickly rebounded after 2009, and have held steady since.

Figure 7 helps put recent employment and wage trends into perspective. The vertical axis measures the average earnings per worker for each major industry sector, relative to the regional (all industry) average. The horizontal axis shows the rate of employment growth between 2001 and 2012. The size of each bubble is scaled according to its 2012 employment.

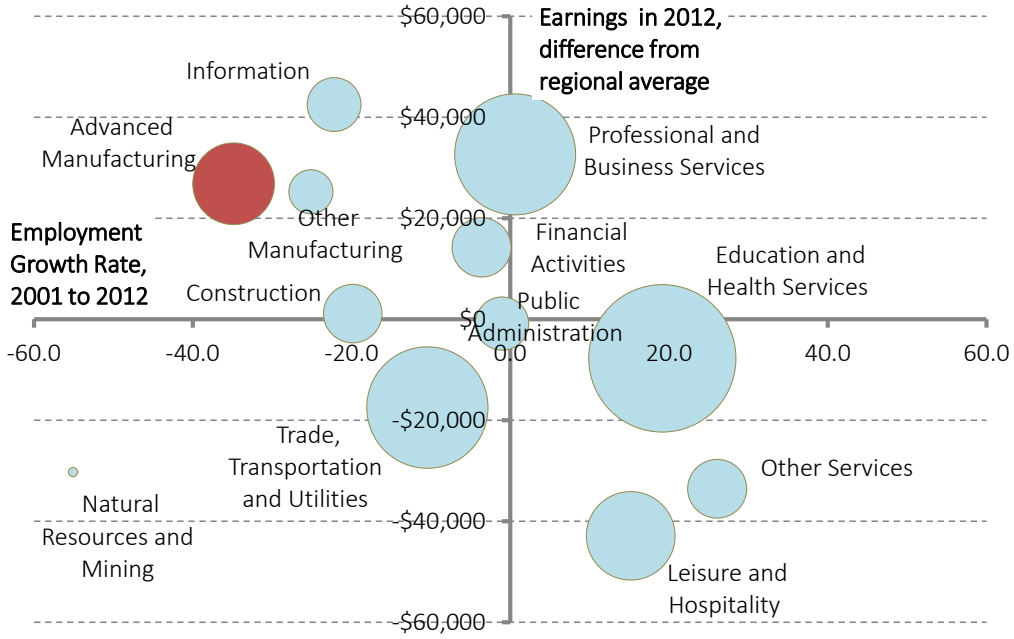
Figure 6
Trends in Real Earnings per Worker in Advanced Manufacturing, Northeast Region vs. the U.S., 2001 to 2012



Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

Advanced manufacturing clearly suffered major job losses over the past 11 years. Yet, it remains a sizable part of the regional employment base and is among the highest-paying. Only two sectors (Information and Professional and Business Services) pay more than Advanced Manufacturing, both of which also suffered net job losses since 2001. In fact, all of the sectors that added jobs since 2001 pay below average wage.

Figure 7
Major Industry Sectors, by Average Earnings, Size, and Growth



Advanced Manufacturing Subsectors in the Northeast Region

Establishments, Employment and Regional Specializations

The Northeast region is dominated by the Computer and Electronics products subsector. Its 370 individual business establishments employ more than 26,000 workers, accounting for over 41% of the entire Advanced Manufacturing sector's employment base in 2012 (Table 2). Computers and Electronics has a regional employment share that is nearly three times the national share—making it not only the most highly concentrated subsector in the region but among the most highly specialized subsectors in any region of the state (Figure 8). This is despite major job loses that have eroded the relative dominance of this subsector in the region relative to 2001.

The Fabricated Metals and Machinery subsector comes in a distant second in terms of total employment, accounting for 13,790 jobs in 2012. But while it employs far fewer workers, the Fabricated Metals subsector is represented by a larger number of regional employers—nearly 600 as of 2012. This is because Computers and Electronics companies tend to be rather large, hiring an average of 71 workers per establishment, while Fabricated Metal shops tend to be rather small, by comparison, with only 25 workers per establishment. Although they may be large relative to other subsectors in the region, Computers and Electronics companies in the Northeast are no larger than their subsector counterparts elsewhere in the Commonwealth, with an average 70 workers per establishment.

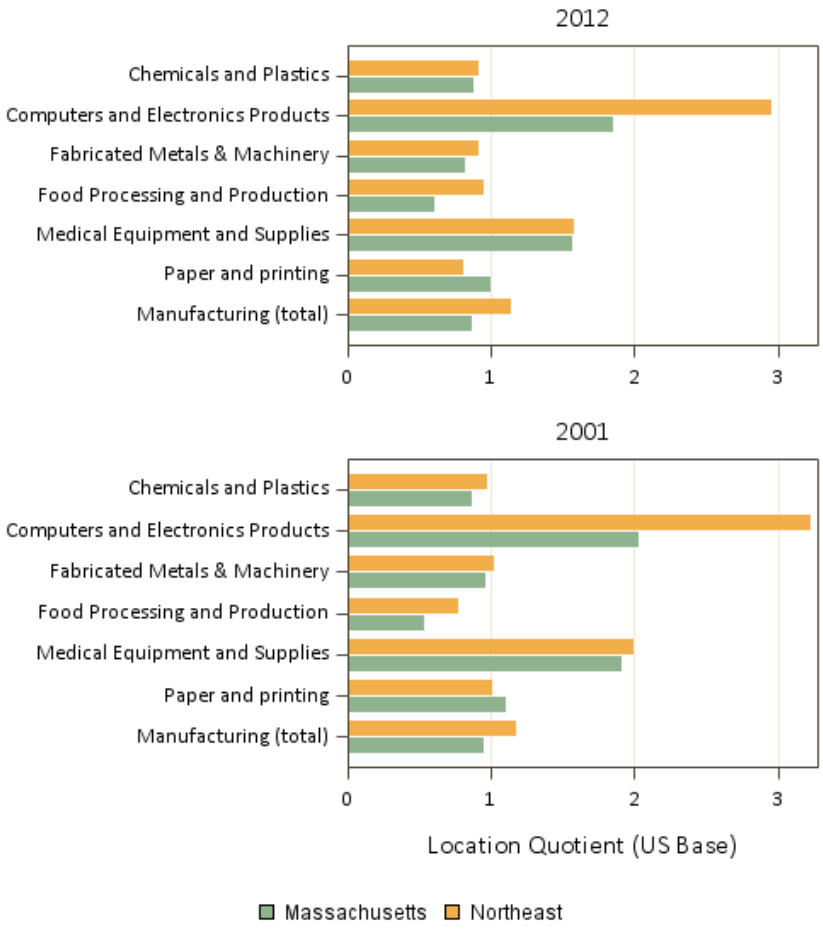
Table 2
Employment, Establishment, and Earnings Summary by Advanced Manufacturing Subsector, 2012

	Establishments			Employment			Real Wage and Salary Earnings	
Sub-sector	Number	Change from 2001	Average Size	Number	Change from 2001	Location Quotient	per worker	Change from 2001
Chemicals and Plastics	152	-59	47.6	7,235	-2,914	0.912	$95,037	$4,998
Computers and Electronics Products	370	-93	71.2	26,350	-20,880	2.950	$115,798	$25,791
Fabricated Metals & Machinery	557	-183	24.8	13,790	-5,799	0.901	$81,334	$9,533
Food Processing and Production	211	-57	44.6	9,418	956	0.943	$44,016	$1,680
Medical Equipment and Supplies	86	-6	34.3	2,948	-993	1.571	$82,063	$10,077
Paper and printing	214	-138	19.2	4,101	-4,525	0.798	$55,325	-$1,846
Advanced Manufacturing (total)	1,590	-536	40.2	63,842	-34,155	1.298	$89,969	$11,330

*Measured in 2013 Dollars

Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's Calculations

Figure 8
Relative Concentration of Employment by Advanced Manufacturing Subsector, Northeast vs. the Commonwealth



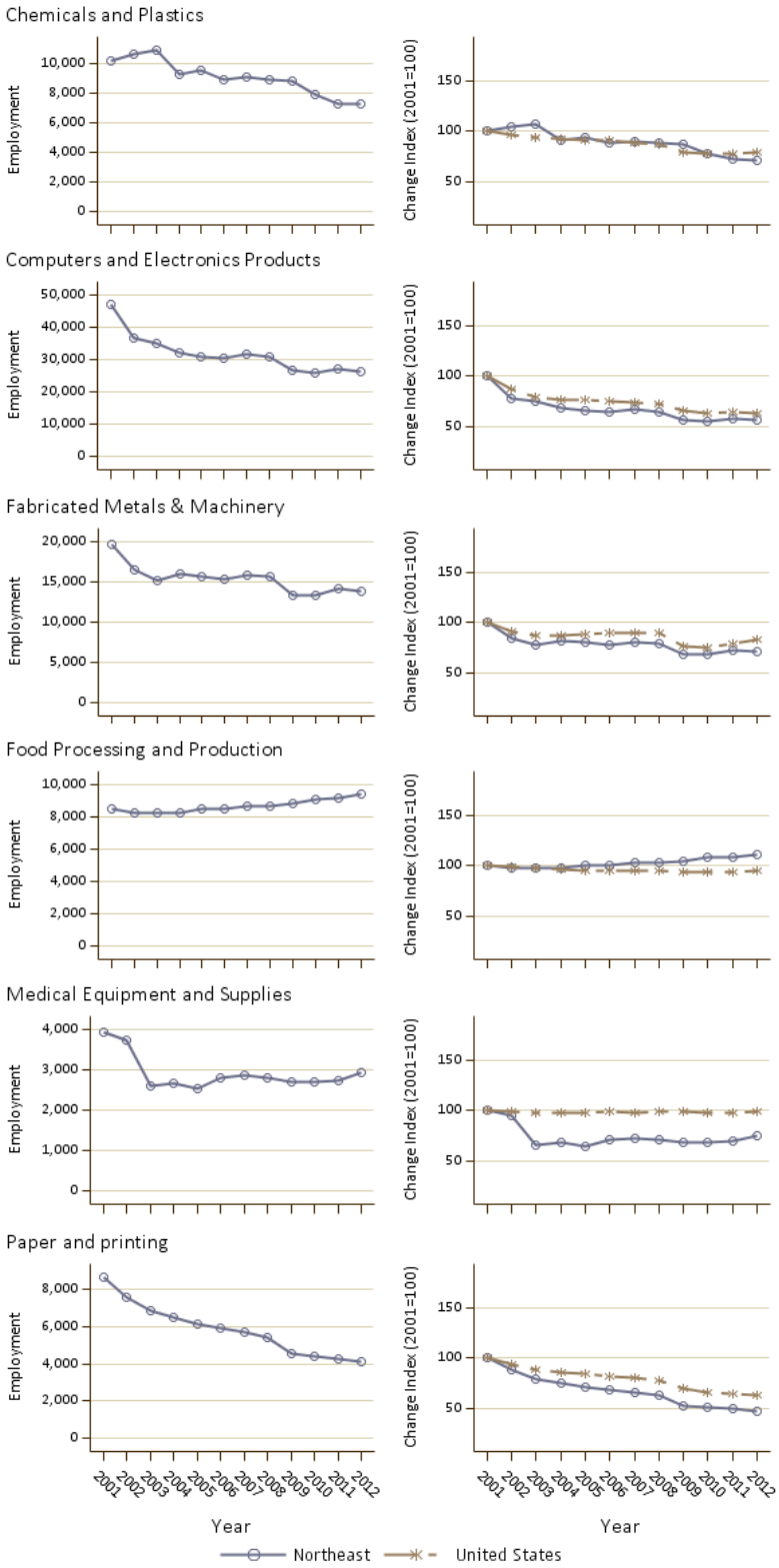
Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

The smallest subsector in the region is Medical Equipment and Supplies. It is represented by only 86 companies and employed just under 3,000 workers in 2012. But while small in absolute terms, the Medical Equipment and Supplies subsector is actually a somewhat concentrated (or specialized) in the Northeast (Figure 8). The Medical Equipment and Supplies subsector in the Northeast region has 1.5 times the share of workers compared to the national average, although similar to the Commonwealth as a whole. And like Computers and Electronics products, the region's relative specialization in Medical Equipment and Supplies has waned in recent years coupling net job losses with growth in other sectors of the regional economy, namely Educational and Health services.

Employment Trends

More so than any other subsector, the fortunes of the Computers and Electronics subsector have also largely dictated the overall trends of the region's Advanced Manufacturing sector over the past decade. This subsector experienced steep job losses in the early 2000's, a slight reversal by mid-decade, and then a second dip coinciding with the onset of the Great Recession in 2008 (Figure 9). The Computers and Electronics subsector has stabilized in the post-recession recovery, but has yet to post any notable job gains. Most of the other subsectors also posted net job losses over the study period with the exception of Food Processing and Production, which added nearly 1,000 jobs since 2001. Subsector gains in the region surpassed those of the subsector nationwide, which saw virtually no net employment growth between 2001 to

Figure 9
Employment Change by Subsector, Northeast Region



Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

2012. The region's Medical Equipment and Supplies subsector is another interesting case. Like Computers and Electronics, it suffered major losses in the early 2000's. Yet the Northeast's Medical and Supplies subsector has held firm in the years since, even adding a small number of jobs in the post-recessionary period while national employment has remained flat. Among the remaining subsectors, we see Chemicals and Plastics essentially mirroring the slow decline appearing in national trends. Fabricated Metals and Machinery also experienced notable employment loss during the previous two recessions, with intermittent periods of stability in-between and since. Paper and Printing has experienced a generally steady annual decline since 2001, following the same general trajectory as the national subsector, but at a somewhat faster pace.

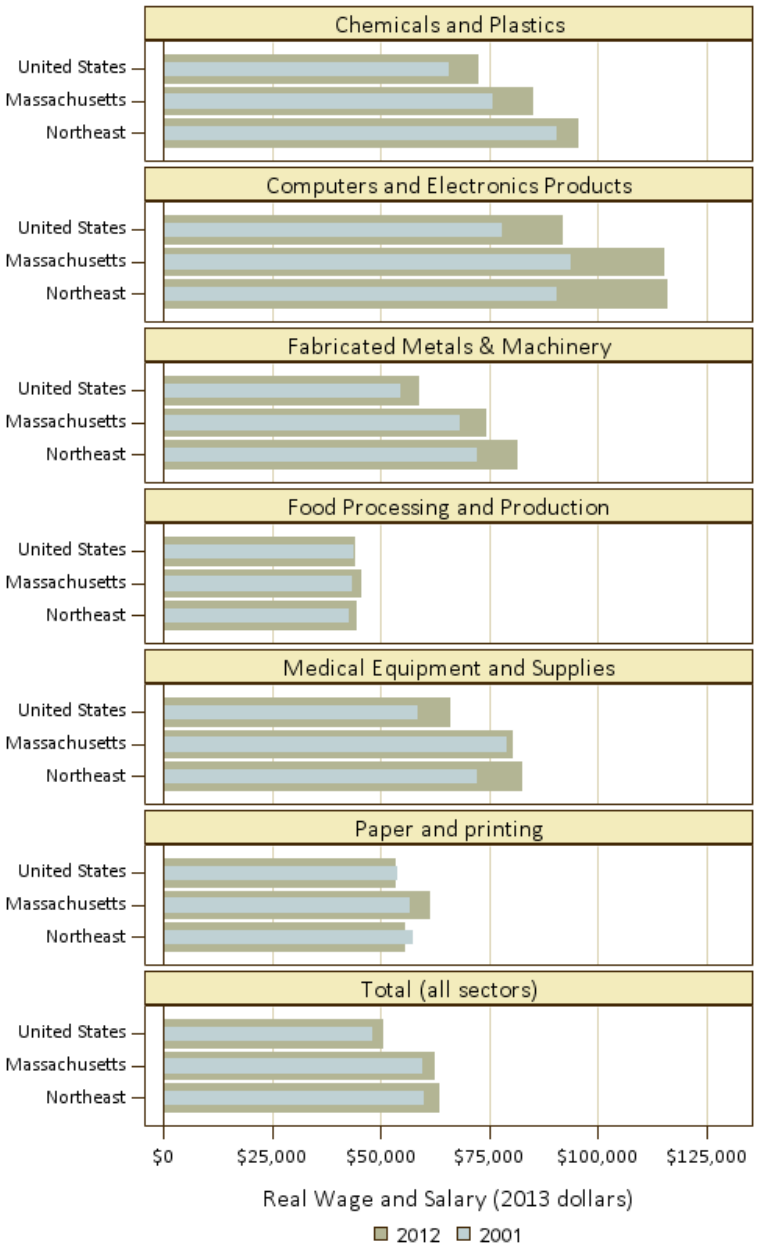
Earnings and Wage Trends

Not only is Computers and Electronics the largest and most specialized subsector in the region. It also pays the most of any subsector in Advanced Manufacturing. The average worker in the Computer and Electronics products subsector earns just over $115,000 per year—

almost double the regional average for all industries and 23% more than average for Advanced Manufacturing (Figure 10). The regional earnings in this subsector are far higher than the national average, but commensurate with the state. Computers and Electronics also experienced the fastest rate of real wage growth of all the regional subsectors. Between 2001 and 2012, annual earnings increased by almost $26,000 per worker; a growth rate of 29 percent. However, it is unclear how much of this growth is due to increases in worker salaries versus selective layoffs among less experienced, and presumably lower-wage workers.

In general, workers in Advanced Manufacturing subsectors earn more than the regional annual average of $63,000. Paper and Printing and Food Processing and Production are exceptions, where workers can expect to earn a respective $8,000 and $20,000 less than the overall regional average. Food Processing and Paper and Printing are also the only two subsectors where workers in the Northeast make less than similar workers in other areas of the state, although all regional subsectors exceed their corresponding national average. These subsectors also experienced real wage losses since 2001, while the remaining Advanced Manufacturing subsectors saw real wages grow over the period.

Figure 10
Annual Earnings per Worker, 2001 to 2012



Source: Massachusetts Department of Labor, Quarterly Employment and Wages (ES-202), Author's calculations

Occupational Profile of Advanced Manufacturing

This section profiles the knowledge, skills and abilities of the Advanced Manufacturing labor pool in the Northeast region. It largely follows a similar structure and format as the companion state-level occupational profile—focusing on the specific occupations identified at the "core" of the Commonwealth's Advanced Manufacturing sector. But there are some important differences. Several of the key data sources used to analyze occupations by industry are only available on a statewide basis. At the regional level data is limited to total (cross-industry) employment and wage figures by occupation. In other words, the figures discussed in this section include not only workers in Advanced Manufacturing, but workers doing similar jobs in other industries, as well. And while these are considered core occupations in Advanced Manufacturing, the number of workers actually working in Advanced Manufacturing may be far less. Yet, we feel that this analysis does provide an accurate portrayal of the *potential* Advanced Manufacturing workforce, otherwise referred to as the labor pool, because it covers occupations with generally similar skills and aptitudes as those found among workers in the industry.

We begin with a brief profile of the entire regional labor force, classified by major occupational groups that are most closely related to Advanced Manufacturing. We follow with a closer examination of the specific core occupations of the Advanced Manufacturing sector as a whole. The section closes with a brief discussions of employment and wage trends for occupations considered core to the six individual Advanced Manufacturing subsectors.

Regional Occupational Structure

Table 3 presents total employment in the Northeast Region across major occupational categories—focusing on those previously identified as particularly prevalent in the Commonwealth's Advanced Manufacturing sector. The largest share of the Northeast region's labor force are in office and administrative support occupations (15%) —in line with the state and most other regions. Yet our state level analysis of the Commonwealth shows that production occupations are the most specialized to the Advanced Manufacturing sector. Although the Northeast region has a slight concentration of production workers relative to the Commonwealth (LQ 1.10), production workers are somewhat less concentrated relative to the US (Table 3). However, workers in the Northeast region are paid higher wages than the nation and slightly higher than the state (Figure 11). The region also hosts a substantially higher concentration of engineering, computer and math, and science based *wo*rkers — reflecting the predominance of Advanced Manufactur-

Table 3

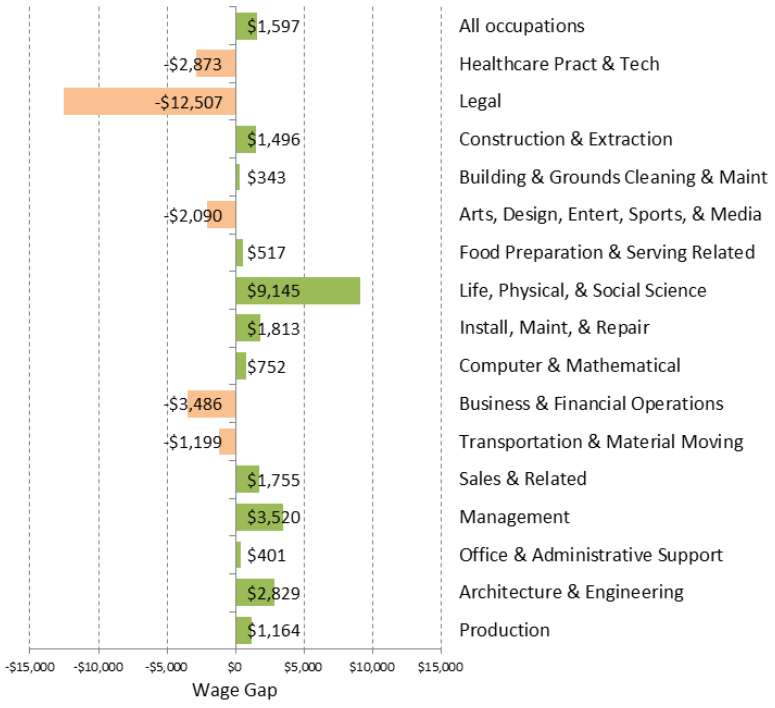
Major Occupational Groups Related to Advanced Manufacturing, Summary Employment and Wage Statistics, 2012

SOC	Occupational Category	Region wide Workers	Industry Share	Location Quotient	Annual wage
51-0000	Production Occupations	46,380	0.05	0.82	$39,293
17-0000	Architecture and Engineering Occupations	29,010	0.03	1.87	$87,222
43-0000	Office and Administrative Support Occupations	126,350	0.15	0.90	$40,371
11-0000	Management Occupations	61,840	0.07	1.47	$127,058
41-0000	Sales and Related Occupations	79,340	0.09	0.87	$47,071
53-0000	Transportation and Material Moving Occupations	38,410	0.04	0.66	$34,694
13-0000	Business and Financial Operations Occupations	43,070	0.05	1.02	$74,582
15-0000	Computer and Mathematical Occupations	44,640	0.05	1.89	$92,417
49-0000	Installation, Maintenance, and Repair Occupations	25,350	0.03	0.76	$52,826
19-0000	Life, Physical, and Social Science Occupations	19,110	0.02	2.63	$86,784
35-0000	Food Preparation and Serving Related Occupations	73,750	0.09	0.97	$26,236
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	12,040	0.01	1.04	$56,459
37-0000	Building and Grounds Cleaning and Maintenance Occupations	25,890	0.03	0.93	$32,626
47-0000	Construction and Extraction Occupations	26,190	0.03	0.80	$58,233
23-0000	Legal Occupations	4,310	0.01	0.64	$96,761
29-0000	Healthcare Practitioners and Technical Occupations	59,520	0.07	1.18	$78,686
00-0000	Total all occupations	857,960	1.00	1.00	$57,769

Source: MA Office Labor and Workforce Development (EOLWD) OES, author's calculations. Includes Major SOC categories with occupations in Advanced Manufacturing indicated by the state report. Wages are reported in 2013 dollars.

Figure 11

Difference in Major Occupational Category Earnings, Region v. State



Source: MA EOLWD, OES; US BLS, OES; author's calculations. In 2013 dollars.

ing employment in Computer's and Electronics, Chemicals and Plastics, and Precision Machining.

Regional employers tends to pay more than the state average in most major occupational groups in the region, with the exception of legal, business and finance, and healthcare workers, who earn notably less (Figure 11). Workers in the life, physical and social sciences do particularly well—earning approximately $9,000 more than the statewide average. These workers tend to focus more on research and development activities than production line work.

Advanced Manufacturing Core/Crossover Occupations

Table 4 reports the core/crossover occupations of the Advanced Manufacturing sector that were identified in our state-level analysis. Occupations that are "core" in a particular subsector are designated by an "X". Table 4 also includes regional employment totals for each occupation, as well as subsector industry employment levels (as reported in the previous section) to provide a sense of each subsector's contribution to

Table 4
Summary Employment and Core Advanced Manufacturing Crossover Occupations, 2012

SOC	Occupational Title	Region wide Workers	Chemicals and Plastics	Computers and Elect.	Fab. Metals and Mach.	Food Process. & Prod.	Medical Equip. and Supplies	Paper and Printing
11-9041	Architectural & Engineering Managers	2,230	x	x	x		x	
51-4011	Computer-Controlled Machine Tool Operators, Metal & Plastic	450	x	x	x		x	
51-4031	Cutting, Punching, & Press Machine Setters, Operators, & Tenders, Metal & Plastic	240	x	x	x		x	x
17-3023	Electrical & Electronics Engineering Technicians	2,460		x	x		x	
51-2023	Electromechanical Equipment Assemblers	1,330		x	x		x	
51-4021	Extruding & Drawing Machine Setters, Operators, & Tenders, Metal & Plastic	870	x	x	x			
51-1011	First-Line Supervisors of Production & Operating Workers	3,200	x	x	x	x	x	x
51-9198	Helpers--Production Workers	1,930	x	x	x	x	x	x
17-3026	Industrial Engineering Technicians	990	x	x	x			x
17-2112	Industrial Engineers	2,690	x	x	x		x	x
49-9041	Industrial Machinery Mechanics	970	x	x	x	x	x	x
11-3051	Industrial Production Managers	1,080	x	x	x	x	x	x
51-9061	Inspectors, Testers, Sorters, Samplers, & Weighers	2,700	x	x	x	x	x	x
51-4041	Machinists	2,320	x	x	x		x	
17-2141	Mechanical Engineers	2,810	x	x	x		x	
51-4072	Molding, Coremaking, & Casting Machine Setters, Operators, & Tenders, Metal & Plastic	70	x	x	x			
51-4081	Multiple Machine Tool Setters, Operators, & Tenders, Metal & Plastic	410		x	x		x	
51-9111	Packaging & Filling Machine Operators & Tenders	1,110	x			x		x
51-2092	Team Assemblers	5,130		x	x	x	x	x
51-4111	Tool & Die Makers	270	x		x		x	x
Subesector Advanced Manufacturing industry employment (ES-202)	Share		11.3%	41.3%	21.6%	14.8%	4.6%	6.4%
	Number		7,235	26,350	13,790	9,418	2,948	4,101

Source: Massachusetts EOLWD, OES and ES-202 data series; author's calculations

the region's Advanced Manufacturing base. It is important to note that the industry employment numbers include only those workers specific to the subsector, regardless of occupation. Whereas the occupational employment totals report all workers in the region, and not just those in Advanced Manufacturing.

In general, we find a significant number of these core/crossover occupations in the region, which we might expect given the size of the Advanced Manufacturing sector in the region. In particular, Computers and Electronics and Fabricated Metals make up a significant share of industry employment in the region. These subsectors share a significant number of core/crossover occupations with each other, as well as Medical Equipment and Supplies, which although comprises a small relative share of employment, is somewhat concentrated in the region relative to the nation. These core subsectors also share a number occupations that have deep labor pools from which to draw workers. Furthermore, the significance of these subsectors in the region and overlap of labor pools should provide ample opportunities for training and education programs to leverage scale economies across the region. Food Processing and Production on the other hand, share a somewhat smaller share of core occupations with the other five subsectors and may be more reliant on specialized training programs for skills specifically demanded by the subsector.

Chemicals and Plastics

While the subsector shares a number of 'core/crossover' occupations with other subsectors, Chemicals and Plastics differs in the share of workers in scientific fields, such as chemists, biologists, and similar types of engineers that have somewhat specialized knowledge relative to other subsectors. Table 5 displays total occupational employment and wage trends in the Northeast region for the occupations identified as core to the Chemicals and Plastics subsector. Among the core occupations associated with Chemicals and Plastics, the most abundant occupations in the region are first-line supervisors of production and operating workers; inspectors, testers and sorters; and industrial engineers. Of these core occupations, the most regionally concentrated workers are those that are specialize in key knowledge domains of the subsector that include chemists; biochemists and biophysicists; chemical technicians; chemical engineers; and microbiologists. Only in the Metrowest/Boston region are similar concentration levels of these occupations present. While in total these workers are not all specific to Advanced Manufacturing, the high concentrations of these types of workers are reflective of regional strengths in science based knowledge domains that are core to the Chemicals and Plastics subsector. In general, employment trends suggest these specialized occupations are growing, while other types of 'core/crossover' occupations have declined since early 2000.

Table 5

Summary Employment and Earnings Statistics, Key Occupations in Chemicals and Plastics, 2012

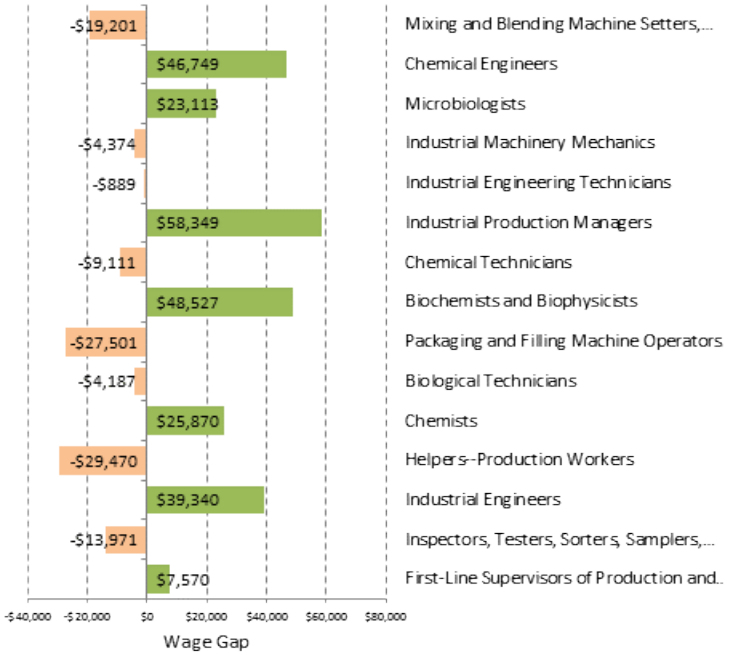
		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
51-1011	First-Line Supervisors of Production and Operating Workers	3,200	-1,040	0.85	$65,339	-$2,032
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	2,700	-240	0.90	$43,798	-$897
17-2112	Industrial Engineers	2,690	-220	1.86	$97,109	$9,895
51-9198	Helpers--Production Workers	1,930	630	0.70	$28,299	-$3,852
19-2031	Chemists	1,890	1,590	3.38	$83,639	-$8,693
19-4021	Biological Technicians	1,240	460	2.59	$53,582	-$2,982
51-9111	Packaging and Filling Machine Operators and Tenders	1,110	-860	0.46	$30,268	$1,282
19-1021	Biochemists and Biophysicists	1,090	800	6.27	$106,296	$13,834
11-3051	Industrial Production Managers	1,080	-650	1.02	$116,118	$16,070
19-4031	Chemical Technicians	1,080	830	2.68	$48,658	-$9,965
17-3026	Industrial Engineering Technicians	990	680	2.23	$56,880	-$1,767
49-9041	Industrial Machinery Mechanics	970	440	0.49	$53,395	-$2,187
19-1022	Microbiologists	750	730	6.14	$80,882	$13,388
17-2041	Chemical Engineers	670	470	3.16	$104,518	$3,534
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	470	-290	0.61	$38,568	$1,251

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

In general, the science based occupations earn significantly higher annual wages relative to the regional average of $57,769 (Figure 12), though there is a wide range. More nuanced, production oriented occupations and those that cross-over subsectors tend to earn less than the regional average. These differences may be reflective of various specializations, education, and skill requirements of these workers relative to the broader labor pool.

Figure 12

Difference in occupational earnings for workers in Chemicals and Plastics v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. Wages in 2013 dollars.

Computers and Electronics

The types of workers in the Computers and Electronics subsector are characterized as hav-

ing a large number of computer and math occupations, as well as engineers. Core occupations tend to be highly specialized to this subsector and include occupations such as electrical equipment production, electrical engineering, and semiconductors processing. Table 6 displays the total industry occupational employment and wage trends in the Northeast region for the occupations identified as core to the Computers and Electronics subsector (for the occupations reported in the OES data series). As the largest subsector in the region, the labor pool of key occupations is expectedly high as well, indicated by employment levels. For example, occupations such as software developers or mechanical, electrical, and industrial engineers are large in numbers. Most all core occupations reported show high levels of regional concentration relative to the US; most occupations showing a location quotient of well over 1. Employment growth varies across core occupations, with roughly half increasing and the other half decreasing since 2001.

Average wages of these occupations are significantly higher than the regional average across all occupations (Figure 13). While the total numbers reported here are for the broader labor force and may not be specific to the subsector, employers in the region have a substantial pool of workers to draw from and training efforts may benefit from scale and cross collaboration with related industry sectors outside of Advanced Manufacturing.

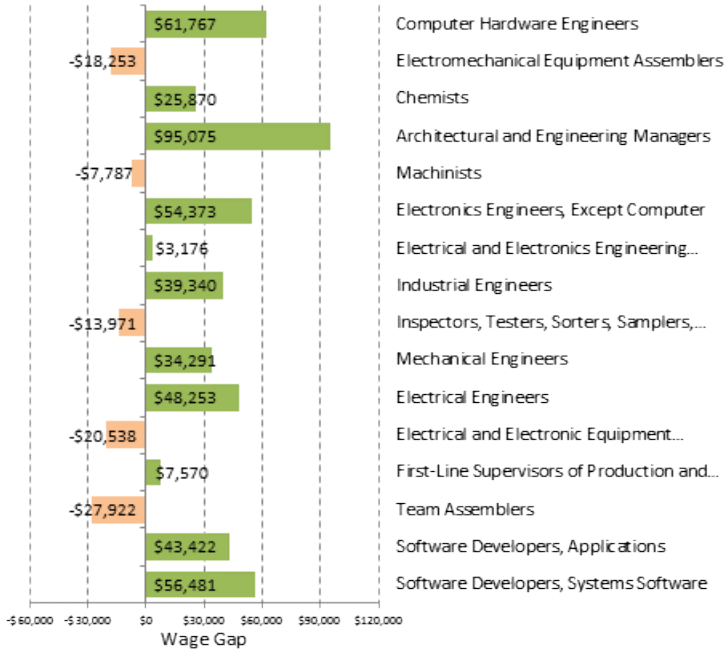
Table 6

Summary Employment and Earnings Statistics, Key Occupations in Computers and Electronic Products, 2012

		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
15-1133	Software Developers, Systems Software	9,460	-	3.67	$114,250	-
15-1132	Software Developers, Applications	8,990	-	2.33	$101,191	-
51-2092	Team Assemblers	5,130	-3,330	0.77	$29,847	-$4,235
51-1011	First-Line Supervisors of Production and Operating Workers	3,200	-1,040	0.85	$65,339	-$2,032
51-2022	Electrical and Electronic Equipment Assemblers	3,130	-450	2.41	$37,231	$1,200
17-2071	Electrical Engineers	3,020	750	2.86	$106,022	$4,658
17-2141	Mechanical Engineers	2,810	960	1.69	$92,060	-$2,308
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	2,700	-240	0.90	$43,798	-$897
17-2112	Industrial Engineers	2,690	-220	1.86	$97,109	$9,895
17-3023	Electrical and Electronics Engineering Technicians	2,460	100	2.59	$60,945	$1,884
17-2072	Electronics Engineers, Except Computer	2,340	1,520	2.63	$112,142	$8,840
51-4041	Machinists	2,320	-740	0.91	$49,982	-$1,588
11-9041	Architectural and Engineering Managers	2,230	-690	1.80	$152,844	$19,726
19-2031	Chemists	1,890	1,590	3.38	$83,639	-$8,693
51-2023	Electromechanical Equipment Assemblers	1,330	330	4.04	$39,516	-$3,435
17-2061	Computer Hardware Engineers	1,310	300	2.50	$119,536	$5,022

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

Figure 13
Difference in occupational earnings for workers in Computers and Electronics v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. Wages in 2013 dollars.

Fabricated Metals and Machinery

Relative to other subsectors, Fabricated Metals and Machinery has the highest concentration of 'production' oriented occupations, which comprise about half of the total workforce in the subsector statewide. These include workers that use machining, tools, and other tangible processes to complete work, while the subsector also employs a number of engineering based occupations as well. In the Northeast region, the subsector represents about 20% of total Advanced Manufacturing industry employment and employs a broad range of workers that cut across numerous subsectors. Relatively high employment totals of these core occupations suggest a dense regional labor pool to draw from (Table 7). The region employs a significant number of team assemblers, engineering, and machining related occupations. However, the region is somewhat under concentrated in a number of the core occupations, with the exception of engineers and electromechanical equipment assemblers. Likewise, the number of core subsector workers has generally declined since 2001. The large core labor pool presence of the subsector in the Northeast region should provide advantages for the development of training programs due to demand for workers in the subsector from an aging workforce. Yet, the substantial decline in subsector employment over the past decade should also inform key areas for retraining dislocated workers in these occupations, particularly occupations such as Team Assemblers, Machinists, and Welders, Cutters, and Solderers.

In general, annual wages for the core occupations in Fabricated Metals and Machinery are lower than the regional average for all occupations, with the exception of engineers and managerial type occupations. In addition, wages appear to have decreased across most core occupations in the subsector. The decreases in employment and wages of the subsectors core occupations across the region suggest a potential demand for worker retraining programs targeting displaced workers in Fabricated Metals and Machinery and other related industries employing similar types of workers that may be in decline.

Table 7
Summary Employment and Earnings Statistics, Key Occupations in Fabricated Metals and Machinery, 2012

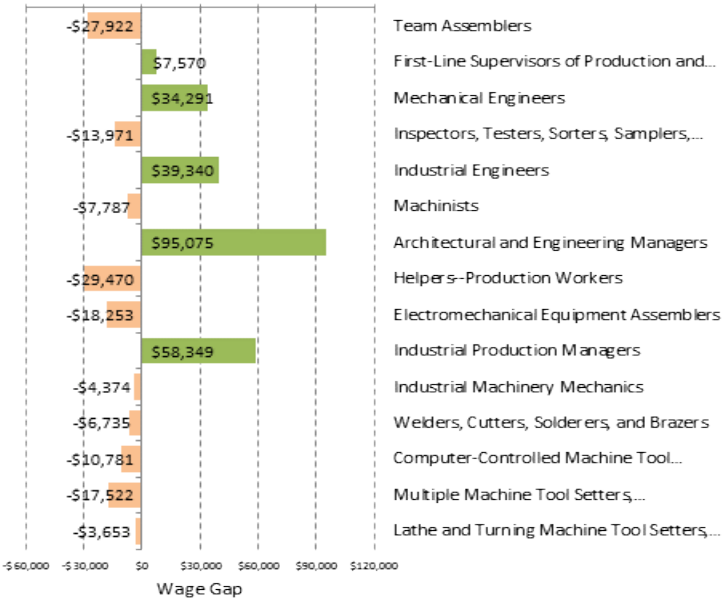
		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
51-2092	Team Assemblers	5,130	-3,330	0.77	$29,847	-$4,235
51-1011	First-Line Supervisors of Production and Operating Workers	3,200	-1,040	0.85	$65,339	-$2,032
17-2141	Mechanical Engineers	2,810	960	1.69	$92,060	-$2,308
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	2,700	-240	0.90	$43,798	-$897
17-2112	Industrial Engineers	2,690	-220	1.86	$97,109	$9,895
51-4041	Machinists	2,320	-740	0.91	$49,982	-$1,588
11-9041	Architectural and Engineering Managers	2,230	-690	1.80	$152,844	$19,726
51-9198	Helpers--Production Workers	1,930	630	0.70	$28,299	-$3,852
51-2023	Electromechanical Equipment Assemblers	1,330	330	4.04	$39,516	-$3,435
11-3051	Industrial Production Managers	1,080	-650	1.02	$116,118	$16,070
49-9041	Industrial Machinery Mechanics	970	440	0.49	$53,395	-$2,187
51-4121	Welders, Cutters, Solderers, and Brazers	790	-680	0.36	$51,034	$3,114
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	450	-380	0.49	$46,988	$3,706
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	410	-	0.73	$40,247	-
51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	340	-110	1.36	$54,116	$4,620

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

Food Processing and Production

The Food Processing and Production subsector has a diverse occupational mix that is at times characteristic of other forms of manufacturing and at times more akin to food services and sales. Many of the core occupations in the Food Processing and Production subsector involve industrial food preparing and processing and are somewhat specialized to the subsector: bakers; food batchmakers; meat, poultry and fish cutters, and food-related machinery operators. About 14% of Advanced Manufacturing employment in the Northeast region is situated in

Figure 14
Difference in occupational earnings for workers in Fabricated Metals and Machinery v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. In 2013 dollars.

Food Processing and Production. While the subsector shares several types of occupations with other subsectors (team assemblers and industrial machinery mechanics), most core occupations are specific to this subsector and are less common across the broader Advanced Manufacturing sector (Table 8). Of the occupations specific to Food Processing and Production, packers and packagers; drivers/sales workers; bakers; and food batchmakers have the largest number of workers. Relative to the nation, the region is somewhat concentrated in these workers, namely packers and packagers; bakers; and batchmakers, while most other core occupations are somewhat underrepresented in the region. Overall, occupational employment appears to have increased since 2001.

Annual wages of subsector core occupations are significantly lower than the Northeast regional average wage with the exception of food scientists and various supervisory roles (Figure 15). In general, wages have declined across most all core occupations since 2001 (Table 8). Continued employment growth in the subsector will demand training programs tailored to workers that have specific subsector skill requirements not found in other subsectors or industries, such as bakers and food science techs.

Table 8
Summary Employment and Earnings Statistics, Key Occupations in Food Processing and Production, 2012

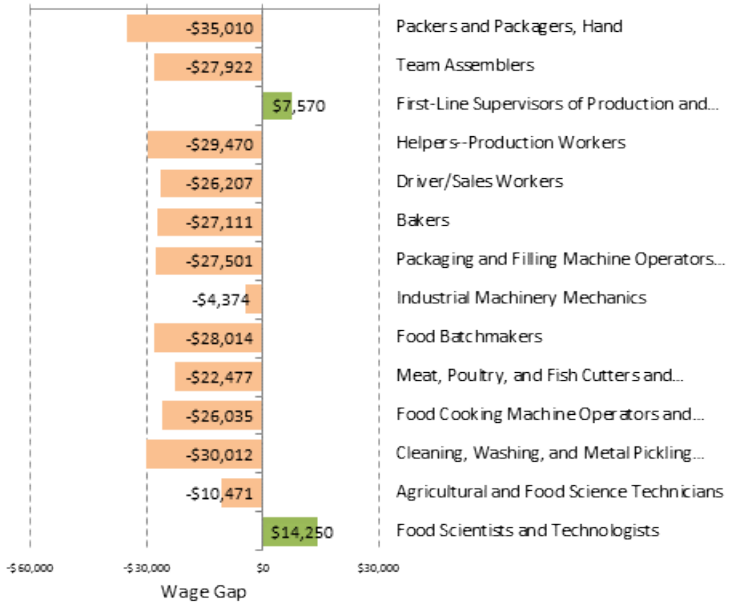
		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
53-7064	Packers and Packagers, Hand	5,620	-390	1.29	$22,759	-$2,284
51-2092	Team Assemblers	5,130	-3,330	0.77	$29,847	-$4,235
51-1011	First-Line Supervisors of Production and Operating Workers	3,200	-1,040	0.85	$65,339	-$2,032
51-9198	Helpers--Production Workers	1,930	630	0.70	$28,299	-$3,852
53-3031	Driver/Sales Workers	1,460	860	0.56	$31,562	-$16,252
51-3011	Bakers	1,280	40	1.24	$30,658	-$1,241
51-9111	Packaging and Filling Machine Operators and Tenders	1,110	-860	0.46	$30,268	$1,282
49-9041	Industrial Machinery Mechanics	970	440	0.49	$53,395	-$2,187
51-3092	Food Batchmakers	820	640	1.24	$29,755	-$4,685
51-3022	Meat, Poultry, and Fish Cutters and Trimmers	230	-	0.22	$35,292	-
51-3093	Food Cooking Machine Operators and Tenders	150	120	0.69	$31,734	$29
51-9192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	120	70	1.14	$27,757	-$2,660
19-4011	Agricultural and Food Science Technicians	50	40	0.42	$47,298	$1,056
19-1012	Food Scientists and Technologists	40	-	0.44	$72,019	-

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

Medical Equipment and Supplies

A majority of core occupations in Medical Equipment and Supplies are production oriented or engineering based occupations. The subsector shares a number of occupations with Fabricated Metals and Machinery, such as engineers, machinists, and other types of machine operators, while a handful of core occupations are specific to the subsector. Medical Equipment and Supplies make up a relatively small share of overall regional Advanced Manufacturing employment (4.6%) in the Northeast. Of the core occupations in the subsector, the re-

Figure 15
Difference in occupational earnings for workers in Food Processing and Production v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. Wages in 2013 dollars.

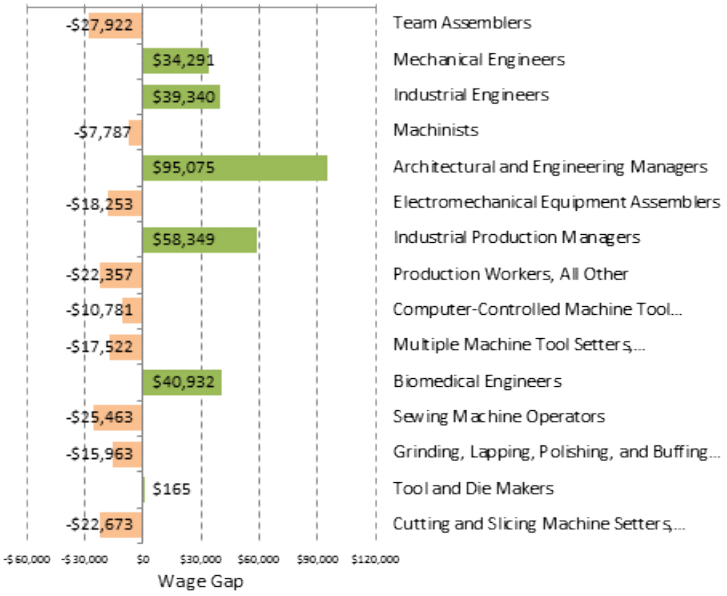
Table 9
Summary Employment and Earnings Statistics, Key Occupations in Medical Equipment and Supplies, 2012

		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
51-2092	Team Assemblers	5,130	-3,330	0.77	$29,847	-$4,235
17-2141	Mechanical Engineers	2,810	960	1.69	$92,060	-$2,308
17-2112	Industrial Engineers	2,690	-220	1.86	$97,109	$9,895
51-4041	Machinists	2,320	-740	0.91	$49,982	-$1,588
11-9041	Architectural and Engineering Managers	2,230	-690	1.80	$152,844	$19,726
51-2023	Electromechanical Equipment Assemblers	1,330	330	4.04	$39,516	-$3,435
11-3051	Industrial Production Managers	1,080	-650	1.02	$116,118	$16,070
51-9199	Production Workers, All Other	770	100	0.53	$35,412	-$1,662
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	450	-380	0.49	$46,988	$3,706
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	410	-	0.73	$40,247	-
17-2031	Biomedical Engineers	390	230	3.15	$98,701	$5,567
51-6031	Sewing Machine Operators	330	-110	0.35	$32,306	$4,421
51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	280	-340	0.61	$41,806	$1,140
51-4111	Tool and Die Makers	270	0	0.54	$57,934	$1,289
51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders	230	-280	0.62	$35,096	-$2,536

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

gion employs a large number of engineers (biomedical, mechanical, and industrial); machinists; and electromechanical equipment assemblers among others (Table 9). Apart from machinists, these occupations are heavily concentrated in the region, while most other core occupations are somewhat underrepresented relative to the nation. Employment across most core occupations in the subsector has declined since 2001, with the exception of mechanical and biomedical engineers and electromechanical equipment assemblers.

Figure 16
Difference in occupational earnings for workers in Medical Equipment and Supplies v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. Wages in 2013 dollars.

With the exception of engineers and managers, average wages are lower in the subsector core occupations than the regional average for all workers (Figure 16). However, wages have risen since 2001 in most core occupations with significant increases in managerial occupations over the period (Table 9).

Paper and Printing

Similar to other Advanced Manufacturing sectors, about half of Paper and Printing occupations are production oriented, although the subsector is distinct from other subsectors in that is has a small share of design and arts oriented workers that support it. The core occupations of the sector are oriented towards printing press operations and are highly specific to paper goods and paper production. Similar to Medical Equipment and Supplies, the Paper and Printing subsector makes up a small percentage of total Advanced Manufacturing industry employment in the Northeast region (6.4%). The largest employment levels of occupations specific to Paper and Printing in the Northeast region are printing press operators; coating, painting, and spraying machine setters, operators, and tenders; and tool and die makers (Table 10). Employment totals for the core labor pool of Paper and Printing have declined since 2001, with the exception of catch all categories, such as helpers and other production workers. Paper and Printing core occupations are relatively underrepresented in the region, which follows the subsectors overall small share of the Northeast's total Advanced Manufacturing employment.

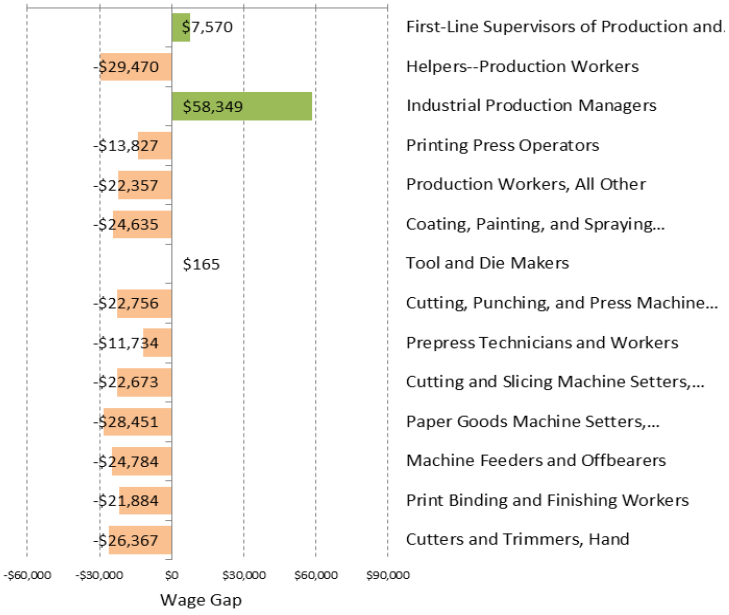
Table 10
Summary Employment and Earnings Statistics, Key Occupations in Paper and Printing, 2012

		Employment			Real Wage	
SOC	Occupational Title	Number	Change from 01	Location Quotient	Per worker	Change from 01
51-1011	First-Line Supervisors of Production and Operating Workers	3,200	-1,040	0.85	$65,339	-$2,032
51-9198	Helpers--Production Workers	1,930	630	0.70	$28,299	-$3,852
11-3051	Industrial Production Managers	1,080	-650	1.02	$116,118	$16,070
51-5112	Printing Press Operators	860	-	0.75	$43,942	-
51-9199	Production Workers, All Other	770	100	0.53	$35,412	-$1,662
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	310	-120	0.59	$33,134	-$6,337
51-4111	Tool and Die Makers	270	0	0.54	$57,934	$1,289
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	240	-670	0.20	$35,013	-$5,489
51-5111	Prepress Technicians and Workers	230	-	0.84	$46,035	-
51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders	230	-280	0.62	$35,096	-$2,536
51-9196	Paper Goods Machine Setters, Operators, and Tenders	180	-470	0.29	$29,318	-$7,511
53-7063	Machine Feeders and Offbearers	150	-160	0.22	$32,985	-$825
51-5113	Print Binding and Finishing Workers	120	-	0.34	$35,885	-
51-9031	Cutters and Trimmers, Hand	60	-10	0.66	$31,402	-$42

Source: Massachusetts EOLWD, OES; author's calculations. Wages in 2013 dollars.

Overall, wages for the core labor pool of Paper and Printing pay wages below the regional average for all occupations in the region (Figure 17). Furthermore, wages have declined since 2001 with the exception of Industrial Production Mangers. Given the small presence of the Paper and Printing in the Northeast and the subsector's relative decline, workforce development efforts might best be targeted towards programs for retraining workers or finding placement opportunities in the larger subsectors of the region that boast more employment opportunities for workers with similar skills and knowledge requirements.

Figure 17
Difference in occupational earnings for workers in Paper and Printing v. regional average wage across all workers



Source: MA EOLWD, OES; author's calculations. In 2013 dollars.

Occupational Skills and Knowledge Requirements

This section profiles the skill and knowledge stocks of workers in the Northeast region across the six Advanced Manufacturing subsectors. As discussed in the state-level report, we link regional occupation employment data to the typical job requirements in 35 skill domains, as reported by the Bureau of Labor Statistics' Occupational Information Network (O*Net). Industry-specific occupational data is not reported at the regional level. Thus, our analysis is more indicative of the skills of the overall labor force or potential labor pool, and not exclusively to workers in Advanced Manufacturing in the Northeast Region. For example, reported employment totals for Industrial Production Managers include workers in Advanced Manufacturing as well as those working in other sectors: such as Transportation, Installation, and other areas.

To do this, we follow a similar method as the state level report where we calculate a weighted average skill level based upon the employment totals and relative skill level reported in the O*Net for each subsector's core occupations. Average skill levels are then ranked from highest to lowest (top to bottom) and indicated by the blue line in each chart labeled "subsector core occupation skill level." Plus signs indicate the regional average skill score weighted across all occupations in all industries reported in the regional OES files. Finally, the horizontal bars indicate the number of workers in a particular subsector's core occupations have an above average skill level, measured using the all occupation weighted average (plus signs) for each region. These measures help to identify strengths of potential labor pool for each subsector and Advanced Manufacturing across the Northeast region. Knowledge requirements, characterized as post-secondary education, experience, on-the-job training, and in-plant training levels, are reported in years and as comparisons across subsector requirements. An 'all occupation' regional average is indicated by a vertical bar and provides a benchmark to compare subsector knowledge requirements to the broader regional labor pool. The remainder of this section presents the skill requirements for each subsector followed by the knowledge requirements of the regional labor pool.

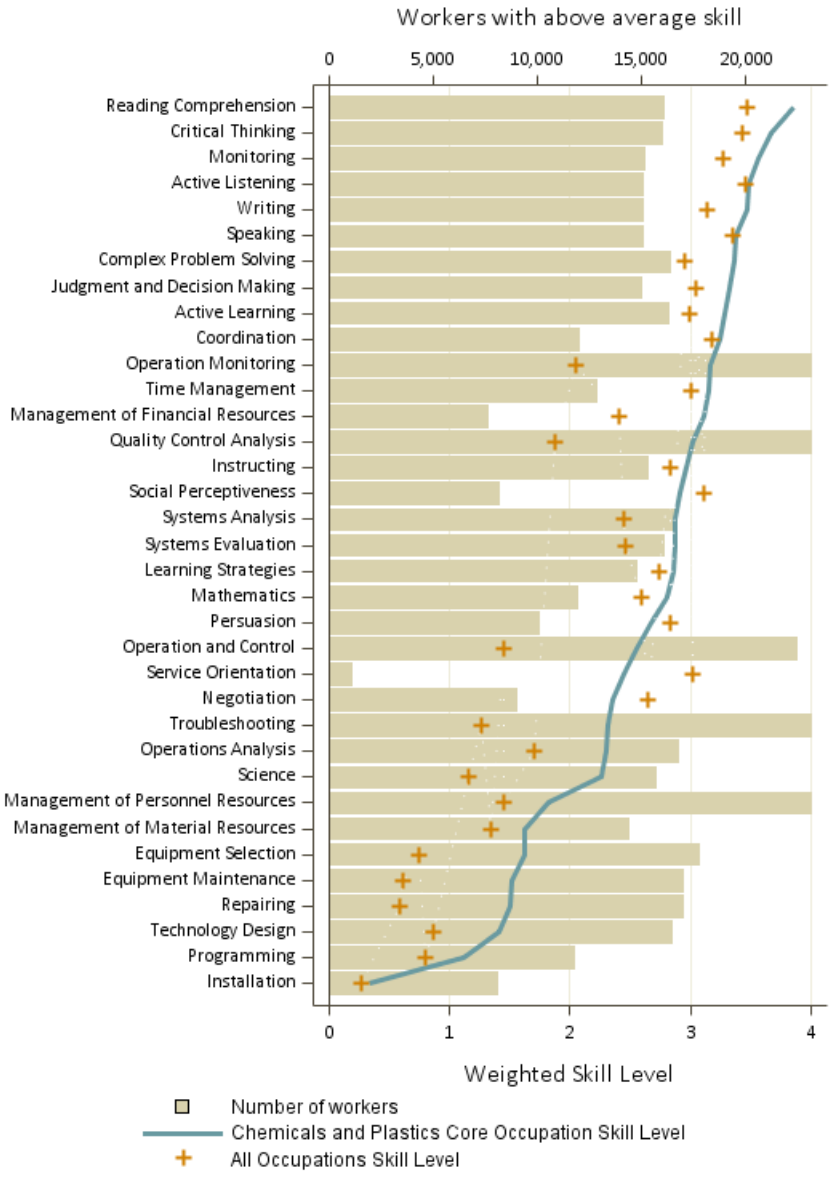
Chemicals and Plastics

Skill requirements in Chemicals and Plastics are fairly diverse compared to most other subsectors. The core labor force for Chemicals and Plastics requires high skill levels in both a number of basic and analytical skill sets, such as reading, critical thinking, active listening, writing, and complex problem solving—skills needed for adaptive learning and reasoning (Figure 18). The Northeast regional labor pool in Chemicals and Plastics tends to require higher skill levels than the regional average across nearly all skills domains

with the exception of more intensive social interaction skills, such as negotiation, persuasion, and service orientation. Skills that score the lowest among the subsector core labor pool are those that relate to equipment usage, programming, and installation, though average skill levels are still higher than the broader labor force.

Skills where there are a high number of workers with above average levels include those that relate to operation and control, as well as personnel management and troubleshooting. Collectively, these data suggest a core labor pool that have average high skill levels that are quite diverse across a number of skill domains and a significant number of workers in the labor pool with skill levels above the regional labor pool requirement.

Figure 18
Skill Requirements in Chemicals and Plastics Occupations



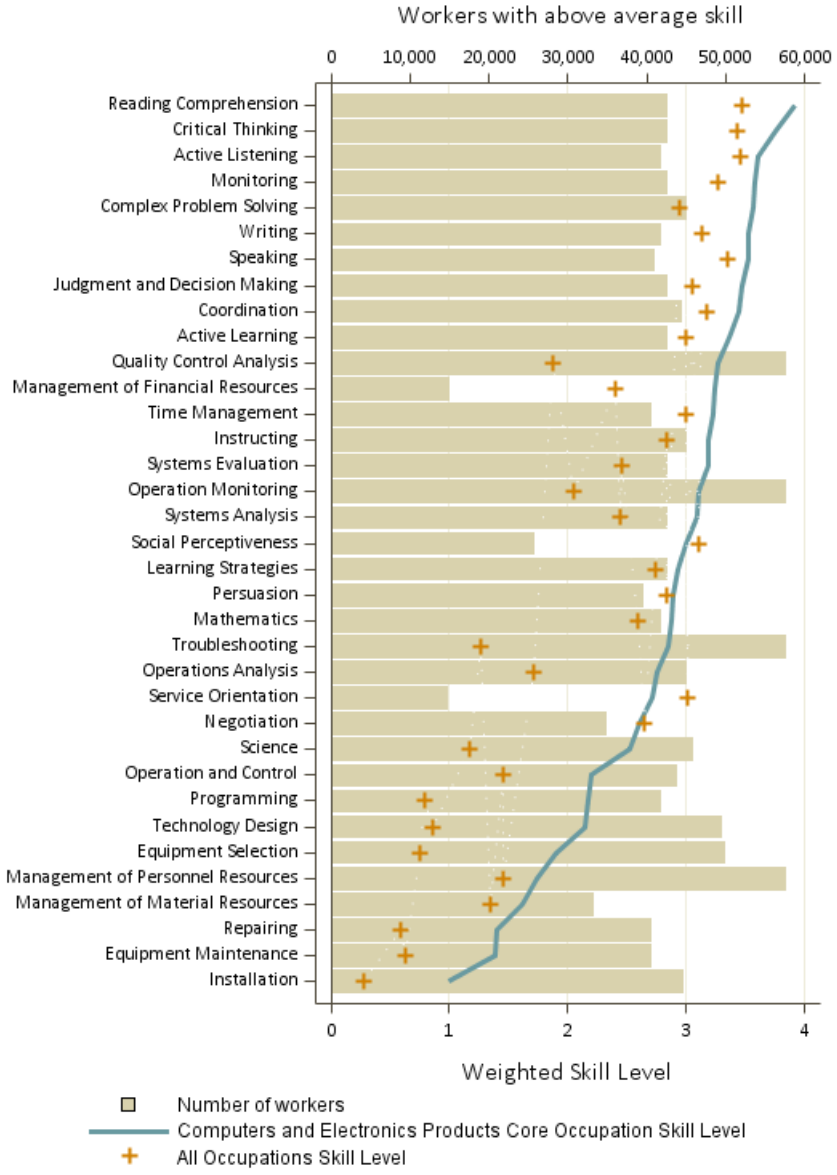
Source: MA EOLWD, OES; US BLS ONET; author's calculations.

Computers and Electronics

The core workforce of Computers and Electronics have the highest and most diverse skill requirements of the six subsectors. This is particularly true in the Northeast region where the subsector labor pool's skill requirements exceed the greater regional labor force nearly every skill domain (Figure 19). Similar to Chemicals and Plastics in the region, workers in Computers and Electronics have high skill requirements in skills that facilitate the acquisition and processing of new knowledge and rather low requirements in service and social perceptiveness, and negotiation. In relation to the broader regional labor force, the core labor pool have significantly higher

average levels in quality control analysis, operations monitoring, troubleshooting, science, and several more technically oriented skills, such as programming technology design, and equipment selection. Across most all skill levels, a consistent number of workers have above average skill requirements in the Northeast region, with the average just over 40,000 workers. Relative to other sectors, the potential core labor pool of Computers and Electronics are highly skilled across most all skill domains, which suggests a strong pool of workers to both pull from and direct comprehensive training programs to maintain the region's strength in the subsector. As the largest subsector in the Northeast region, Computers and Electronics might best benefit from training programs that help build foundational learning skills (such as reading, writing, and critical thinking) as well as more specialized skill sets that transcend other regional subsector strengths, such as Fabricated Metals and Machinery and Chemicals and Plastics, as well as the specialized Medical Equipment and Supplies subsector.

Figure 19
Skill Requirements in Computers and Electronics Occupations

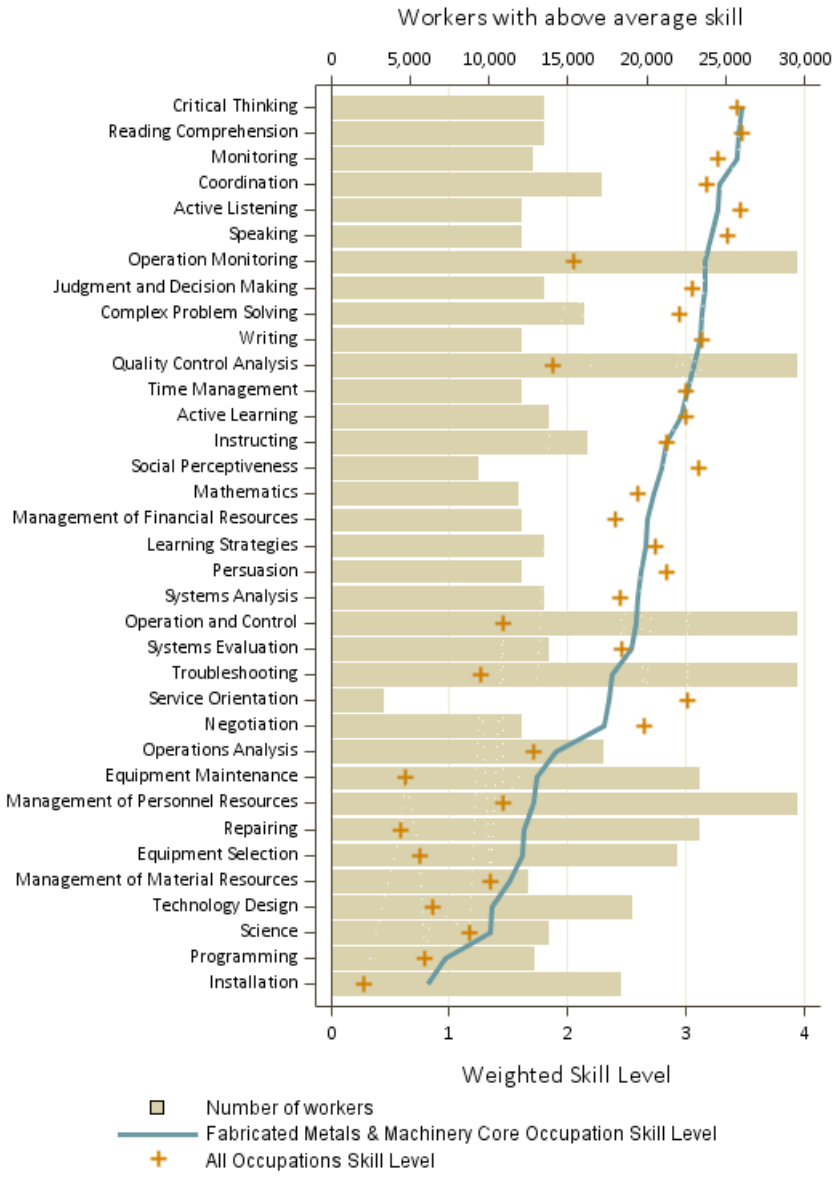


Source: MA EOLWD, OES; US BLS ONET; author's calculations.

Fabricated Metals and Machinery

The types of skills requiring high levels of knowledge in Fabricated Metals and Machinery are primarily technical and technological—operations monitoring, monitoring, quality control, and operations. In addi-

Figure 20
Skill Requirements in Fabricated Metals and Machinery Occupations



Source: MA EOLWD, OES; US BLS ONET; author's calculations.

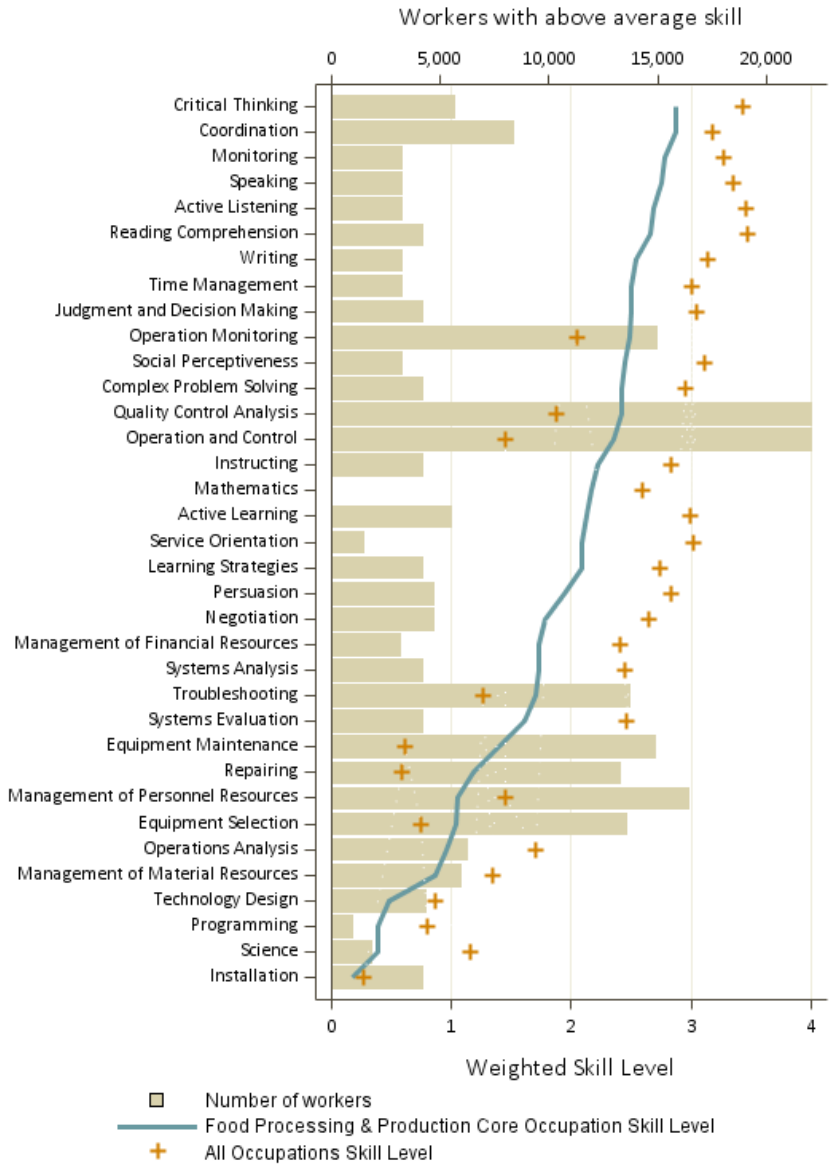
tion, a number of key decision making and information-processing skills also appear among those requiring high levels, such as critical thinking, reading comprehension, problem solving, and judgment. In the Northeast region, skill stocks for the subsector core labor pool are somewhat mixed across skill domains, with many skills at or close to overall labor force averages, while having much higher or lower levels in others (Figure 20). Similar to other subsectors, critical thinking, reading, listening, and speaking—basic learning skills— have the highest average skill levels across the core labor pool. However, other types of skills that are more manual and technical in nature also have high ranking skill levels, such as monitoring skills and coordination. The subsector core labor pool boasts a large number of workers with above average skills critical to the subsector, including operations monitoring, quality control, operation and control, and troubleshooting.

In short, the potential labor pool in Fabricated Metals and Machinery is much more specialized to a select group of skills such as equipment and operation oriented skills, installation, repairing, troubleshooting and quality control. However, despite skill levels above the overall labor force, stocks of these skills in the subsector core labor pool are *lower* than the statewide subsector average, suggesting potential areas for developing training programs to address shortages.

Food Processing and Production

On the whole, Food Processing and Production has few high-level skill requirements, and is characteristic of more traditional forms of low-skilled, routine forms of production than we typically associate with Advanced Manufacturing. There are also few workers in occupations requiring an above average level of skills. The most prevalent skills are in areas related to operations control and monitoring and equipment, while skills more prevalent in other subsectors such as basic learning and complex reasoning are much less required. The subsector labor pool in the Northeast is reflective of these characteristics. With the exception of a handful of skills related to equipment, operations, and quality control, average skill requirements of the subsector's core labor pool are lower than for the overall labor force of the region (Figure 21). However, relative to the statewide subsector averages, skill requirements are, for the most part, higher in the Northeast region, suggesting some advantages for firms in Food Processing and Production relative to other areas of the state. Furthermore, Food Processing and Production is the only subsector that has added net jobs since 2001 and comprises a respectable share of overall regional Advanced Manufacturing employment (15%). The subsector might benefit from training programs directed at skills and knowledge specific to particular core occupations in the subsector, such as machine handling, baking, and food processing activities.

Figure 21
Skill Requirements in Food Processing & Production Occupations

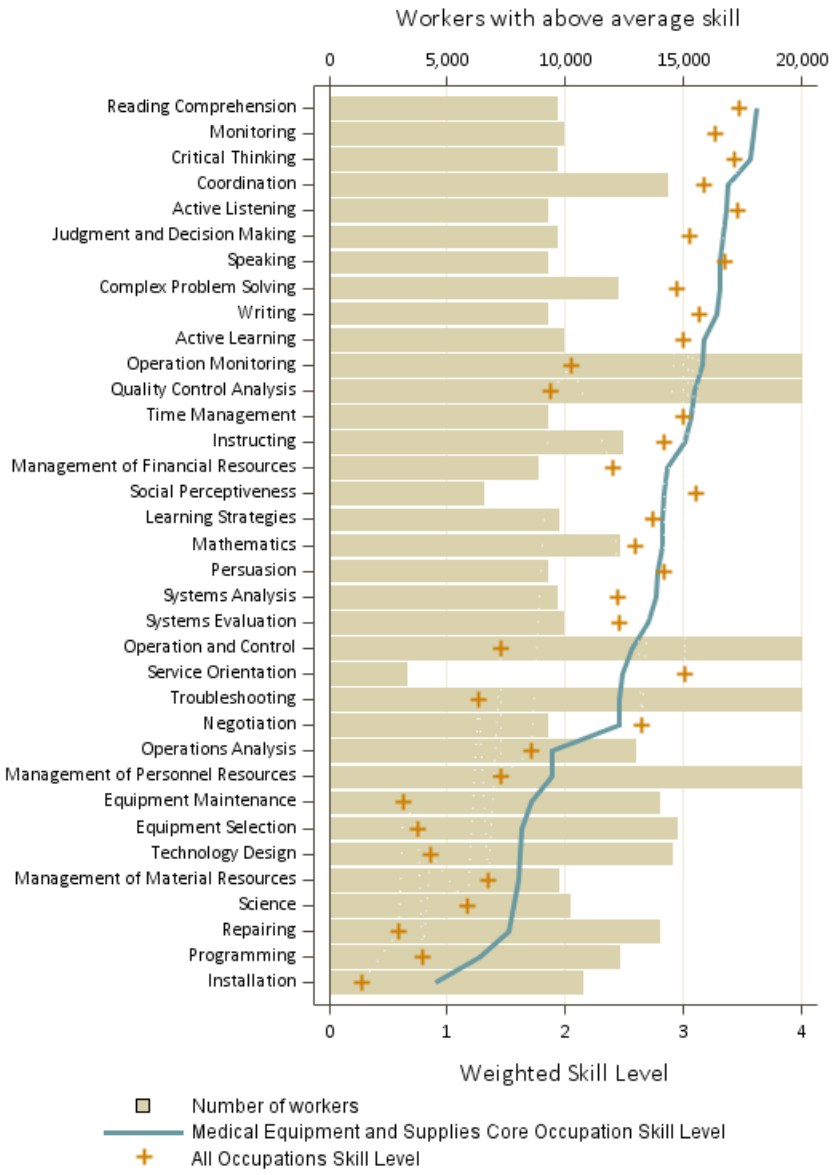


Source: MA EOLWD, OES; US BLS ONET; author's calculations.

Medical Equipment and Supplies

Medical Equipment and Supplies has relatively high skill requirements across a number of technical, basic, and problem solving skill domains. Among the most prominent skills are operation and control, instructing, quality control, technology design, equipment selection, and coordination. In the Northeast, the subsector's core labor pool has higher average skill levels across a majority of skill domains, withstanding a handful of areas related to more advanced social- and service-oriented skills.

Figure 21
Skill Requirements in Medical Equipment and Supplies Occupations



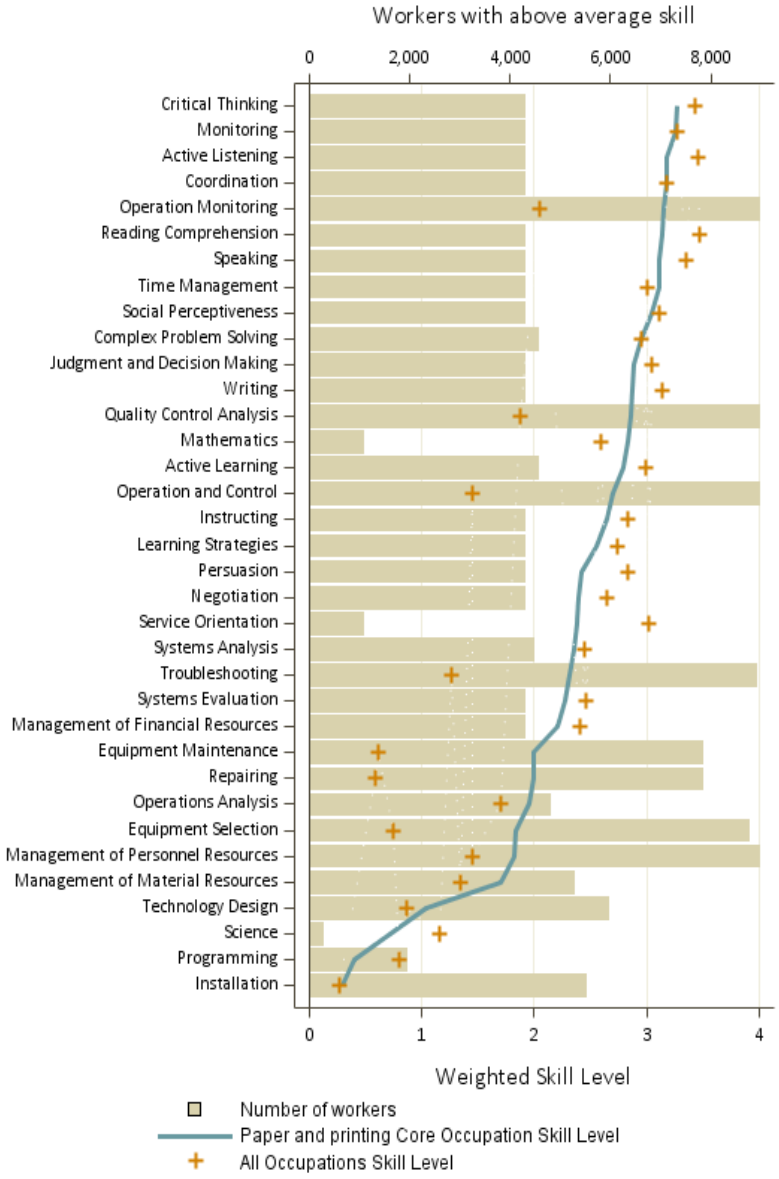
Source: MA EOLWD, OES; US BLS ONET; author's calculations.

Medical equipment shares many core skills in common with other subsectors such as Fabricated Metals and Food Processing and Production. This is particularly true in the areas of quality control, troubleshooting and other monitoring and control skills. Businesses and workforce development officials focused on developing support programs for Medical Equipment and Supplies may well take advantage of these commonalities to compensate for the subsector's small presence in the region which may lack sufficient scale to be cost-effective if narrowly focused to this subsector.

Paper and Printing

The skills profile for the Paper and Printing subsector is similar to Fabricated Metals and Machinery and Medical Equipment and Supplies in that most workers use may production-oriented skills. Yet, Paper and Printing tends to have lower skill requirements than these other subsectors. In the Northeast region, the highest average skill levels are in critical thinking, monitoring, listening and coordination, reflective of the blended nature of the occupational skill requirements (Figure 23).

Figure 23
Skill Requirements in Paper and Printing Occupations



Source: MA EOLWD, OES; US BLS ONET; author's calculations.

Workers in the Northeast region's Paper and Printing core labor pool tend to require skills at a level just below that of the general workforce. This is particularly true in a variety of basic learning and social skills. There are several notable exceptions where the subsectors core labor pool exceed the regional average, namely in areas related to operations; monitoring; and equipment maintenance, repair and selection. As suggested for Medical Equipment and Supplies, it is imperative that workforce development programs in the Paper and Printing subsector leverage the skills it shares with other, larger, sectors to compensate for its relatively small presence in the Northeast,

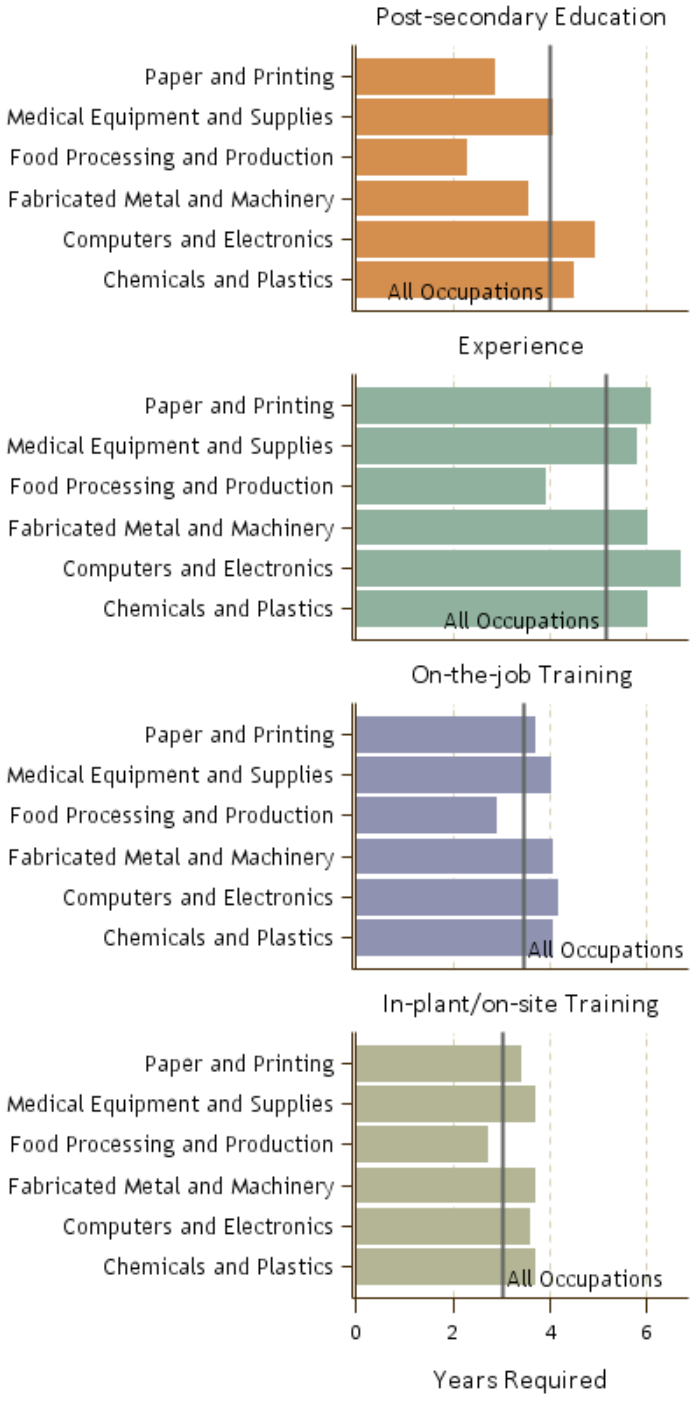
Experience, Education and Training Requirements

Figure 24 presents the average knowledge requirements of the core labor pools across the six subsectors in the Northeast region, reported as the average number of years required in each domain.

Formal educational requirement in the Northeast tend to be higher than what we found for most other regions. The core labor pools in Computers and Electronics and Chemicals and Plastics have education requirements that exceed the regional average—both requiring just below 4.5 years of post-secondary schooling. Educational requirements in Medical Equipment and Supplies basically match the general workforce. Food Processing and Production and Paper and Printing fall well short of the regional educational standard.

With the exception of Food Processing and Production, all subsectors exceed the regional average requirements for years of experience, on-the-job, and in-house training. In general, we find occupational requirements in Advanced Manufacturing subsectors emphasize knowledge acquisition through learning-by-doing and direct application. This is true even in subsectors like Chemicals and Plastics and Computers and Electronics, which also have relatively high expectations for formal schooling.

Figure 24
Knowledge Requirements of Core Subsector Labor Pools



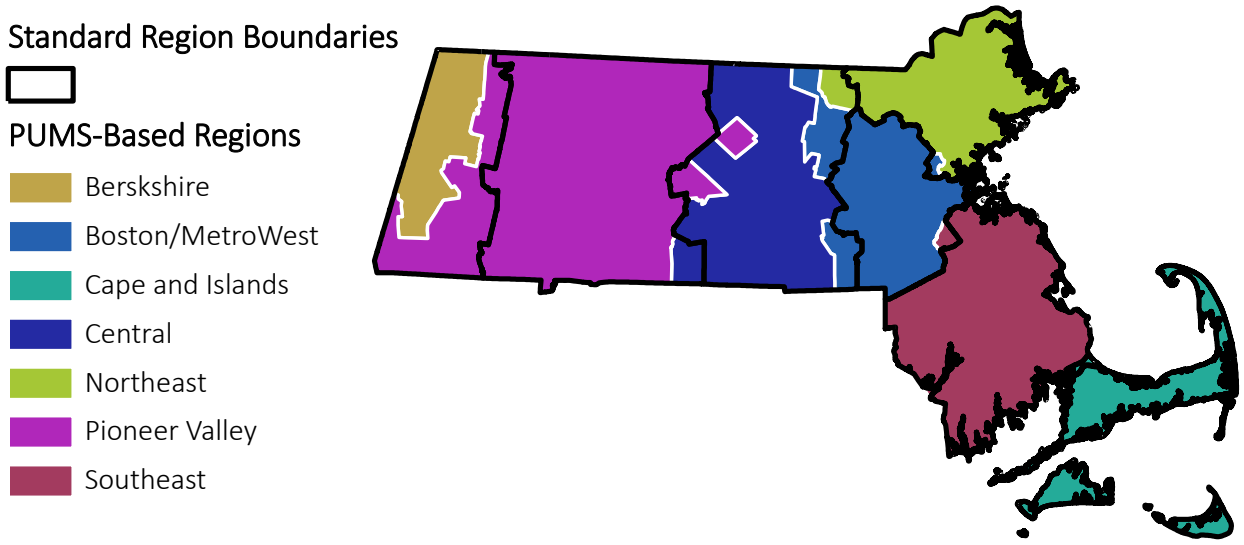
Source: Massachusetts EOLWD, OES; US BLS ONET; author's calculations.

Profile of the Advanced Manufacturing Workforce

This final section looks at the people that work in the Advanced Manufacturing sector of the Southeast Region in terms of race, gender, citizenship status, income, education, and commuting patterns. As in the state report, our demographic profile heavily relies on information from the American Community Survey Public Use Microsample (ACS PUMS) — a representative household survey conducted by the U.S. Census Bureau. It is important to keep in mind that the ACS PUMS is a sample, and not a full census count, and as such is prone to error. This is especially true in smaller regions and/or for analysis based on finely detailed subject categories where there is likely to be few survey respondents. While we provide some detailed estimates in Table 11 and the figures that follow, we warn the reader against interpreting our results as highly precise estimates, but should instead be thought of as revealing general tendencies and trends.

As a final note: our demographic profiles are based on slightly different regional definitions than the rest of the study. This is because the ACS PUMS does not use standard geographic jurisdictions (e.g. towns, counties, and metropolitan areas) but rather its own jurisdictions called PUMAs (Public Use Micros-ample Areas). While we deliberate design each PUMA-based region to closely match our standard (WIA-based) regional boundaries, some differences were unavoidable (Figure 25). The boundaries for the Northeast change very little under the PUMS boundaries—it gains a community from the Boston/MetroWest region and also loses one.

Figure 25
PUMS-Based Study Region Boundaries used in Demographic Analysis



Table

Summary, Demographic Profile of the Advanced Manufacturing Workforce, Northeast Region

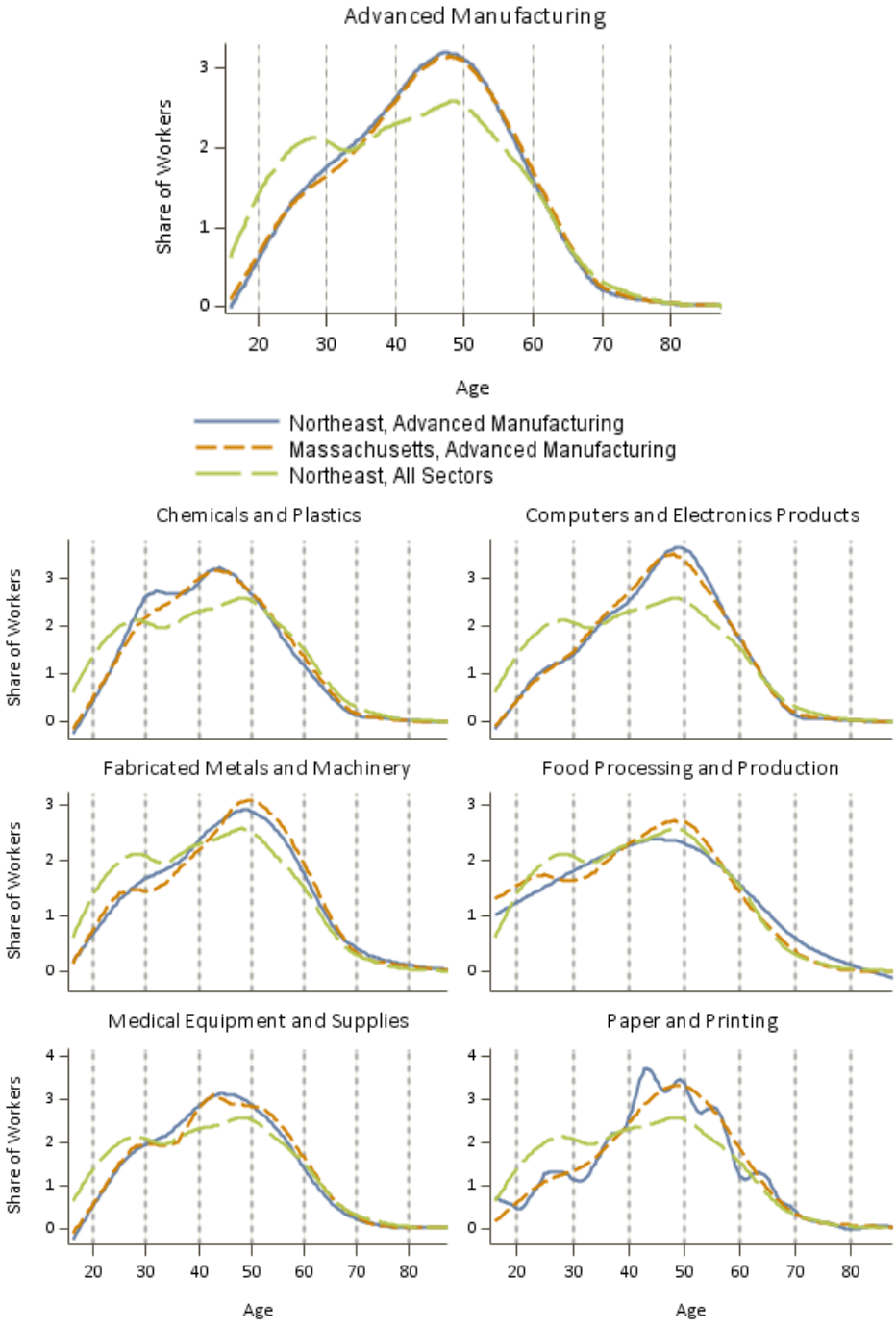
	Advanced Manufacturing	Chemicals and Plastics	Computers and Electronics Products	Fabricated Metals & Machinery	Food Processing & Production	Medical Equipment and Supplies	Paper and printing	All Industries
Age								
Median	45.0	42.0	46.0	46.0	42.0	44.0	46.0	42.0
Under 25 years old	5%	4%	11%	6%	6%	4%	4%	12%
25 to 39 years	29%	26%	28%	27%	23%	38%	31%	31%
40 to 54 years	46%	49%	38%	43%	46%	44%	46%	36%
55 years or older	20%	21%	23%	24%	24%	15%	18%	20%
Race								
White	80%	78%	79%	88%	72%	80%	88%	83%
African American	2%	3%	2%	2%	4%	1%	1%	4%
Asian	12%	13%	16%	6%	6%	13%	3%	6%
Other	5%	4%	3%	3%	14%	5%	7%	5%
More than one race	1%	1%	1%	1%	4%	1%	2%	2%
Female	31.5%	38.4%	29.2%	22.1%	40.2%	35.3%	28.3%	47.3%
Place of Birth								
Massachusetts	47.0%	39.4%	44.3%	60.6%	39.1%	46.6%	66.3%	55.2%
Other New England	7.1%	8.8%	7.6%	7.4%	4.6%	5.7%	3.9%	6.1%
Other United States	19.8%	25.3%	21.2%	13.8%	12.1%	21.7%	15.8%	18.0%
Outside United States	26.1%	26.4%	26.9%	18.3%	44.2%	26.1%	14.1%	20.8%
Median Income (2012 dollars)								
Family Income	$99,760	$112,419	$112,600	$86,398	$58,978	$104,160	$77,085	$86,232
Personal Income	$60,767	$71,148	$71,898	$50,639	$33,948	$70,000	$43,457	$42,132
Wage and Salary Income*	$58,742	$70,000	$70,000	$48,424	$31,340	$66,066	$40,656	$38,000
Educational Attainment								
Less than High School	7%	4%	4%	8%	27%	5%	5%	6%
High School Diploma or GED	22%	13%	19%	35%	33%	13%	39%	22%
Associates Degree or Some College	22%	16%	23%	27%	19%	26%	26%	24%
Bachelors Degree or Higher	49%	67%	54%	30%	22%	56%	30%	47%
Commuting								
Ave. Travel Time to Work (mins)	31.9	35.1	32.5	30.3	25.0	33.5	29.1	26.2
Region/State of Primary Residence								
Berskshire	0%	0%	0%	0%	0%	0%	0%	0%
Boston MetroWest	15%	26%	15%	8%	8%	13%	10%	14%
Cape and Islands	0%	0%	0%	0%	0%	0%	0%	0%
Central	4%	3%	5%	2%	2%	4%	4%	2%
Northeast	64%	55%	61%	70%	81%	63%	68%	73%
Pioneer Valley	0%	0%	0%	0%	0%	0%	1%	0%
Southeast	3%	4%	2%	4%	2%	3%	2%	3%
Other State	15%	12%	17%	15%	7%	16%	16%	8%

*Note: Wage and Salary Income reported in the ACS is different than the Total Wage and Salary reported from the Bureau of Labor Statistics and State Affliates. The ACS is based on a much smaller sample of the workforce and does not include the dollar value of benefits as reported in BLS employer surveys.

Age

As found for the Commonwealth as a whole, the Advanced Manufacturing workforce of the Northeast region may soon be facing an acute labor shortage if action is not taken in the near future. The median Advanced Manufacturing worker is currently 45 years old. Within the next ten years, 20 percent of the region's Advanced Manufacturing workforce will approach or enter the traditional retirement age of 65 years. Within the next twenty years, that portion will jump to over 50 percent, with few younger workers currently in the pipeline to replace them (Figure 26).

Figure 26
Age Distribution of the Advanced Manufacturing Workforce



Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, Author's Calculations

The age distributions for the six subsectors in the Northeast follow the same general pattern, although with some notable differences. Overall, we see relatively little variation in age structure across regions beyond that attributed to sampling error. Instead, most closely match the statewide age distribution for the subsector. Fabricated Metals and Machinery and Computers and Electronics are the oldest subsec-

tors, each with a median age of 46 years and nearly a quarter of the current workforce age 55 or higher. Paper and Printing also has a median age of 46, but the relatively small sample sizes of workers in this subsector makes for a rather erratic age distribution.

The 'youngest' subsectors are Food Processing and Production and Chemicals and Plastics, where the typical worker is 42 years old. The age distribution for Food Processing and Production is a bit 'flatter'—meaning that there are more relatively younger workers in the pipeline. Chemicals and Plastics also skews a bit younger, where the typical worker is also in his/her early forties and there appears to be a secondary peak of workers in their early thirties.

Race, Gender and Nativity

The workforce of Advanced Manufacturing is predominantly white, but slightly more diverse than the overall workforce of the Northeast (Table 11). Asians are particularly well represented relative to their size in the overall workforce, while African Americans are underrepresented. The degree of racial diversity in Advanced Manufacturing varies by subsector, and again closely mirrors what we found for the state as a whole. Food Processing is the most diverse, with nearly 28 percent of the workforce made up by non-whites. Fabricated Metals and Paper and Printing are the least diverse, with racial minorities comprising less than twelve percent of the overall workforce.

Although predominantly white, Advanced Manufacturing in the Northeast has a higher than average share of foreign born workers—26% compare to the all industry average of 20%. Only Fabricated Metals and Paper and Plastic have fewer foreign born workers than the regional average. Food Processing has a particularly high share of foreign born workers (44%). Roughly half of those currently working in Advanced Manufacturing are Massachusetts natives, with particularly high shares of locals found in the Paper and Printing and Fabricated Metals subsectors.

Advanced Manufacturing is also predominantly male, and the gender gap varies considerably by occupation and industry. Women make up only 32% of the Northeastern Advanced Manufacturing workforce. While women are underrepresented in every subsector, the gender divide is largest in Fabricated Metals and Paper and Printing and smallest in Food Processing and Chemicals and Plastics. The largest share of women working in Advanced Manufacturing work in production occupations (26%)—a share just slightly higher than men (Figure 27). However, women are heavily specialized in administrative and office support occupations—20% of women compared to only 5% of men. By contrast, men are far more prominent than

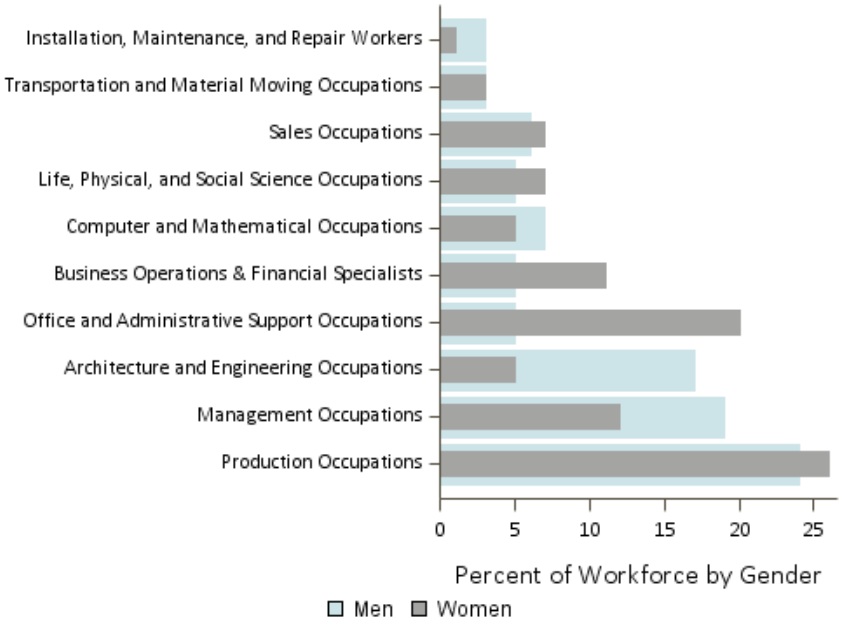
women in management and architecture and engineering occupations — typically the most highly paid occupations in the sector.

Educational Attainment and Income

The Advanced Manufacturing workforce in the Northeast is among the most highly educated in the Commonwealth. The vast majority (71%) of people working in the Northeast Advanced Manufacturing sector have at least some college education (Table 11). This matches the region's overall level of educational attainment and is notably higher than the Commonwealth sector average of 66%. In part, this reflects the regional dominance of the Computers and Electronics subsector, which tends to have relatively high educational requirements. However, it is worth noting that the Northeast workforce exceeds the state average for college educated workers in every subsector, with the exception of Food Processing and Production.

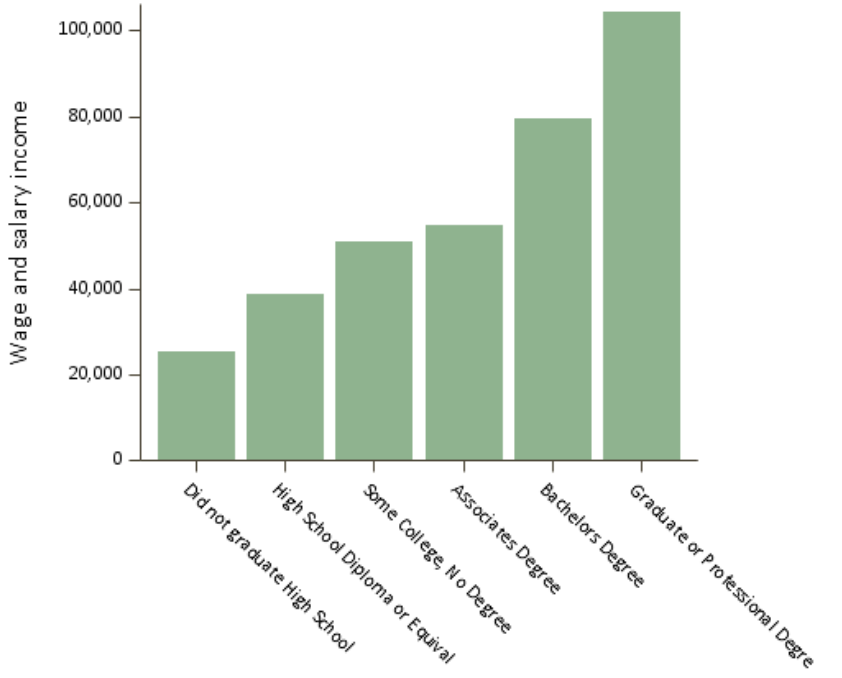
Those with higher degrees also earn considerably more than those with-

Figure 27
Gender Differences by Major Occupation Groups in Advanced Manufacturing



Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, Author's Calculations

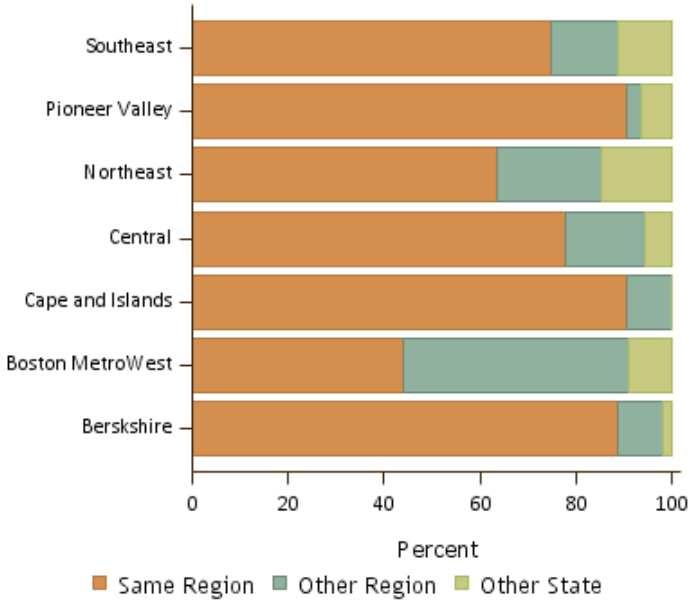
Figure 28
Median Wage and Salary Earnings by Education, Advanced Manufacturing



Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, Author's Calculations

out (Figure 28). Some of this discrepancy is due both to differences in educational requirements across subsectors, but not all. Workers without high school diplomas comprise nearly 22% of the regional Food Processing and Production workforce, which pays below average wage levels. Food Processing also hires a notably larger percentage of minorities, women, and foreign born—and pays considerably less than the other Advanced Manufacturing subsectors. Fabricated Metals and Machinery also hires a disproportionate share of workers without high school diplomas. But in contrast to Food Processing and Production, Fabricated Metals pays considerably higher than average earnings and is characterized by relatively low shares of foreign born, minority and female workers.

Figure 29
Place of Residence by Region

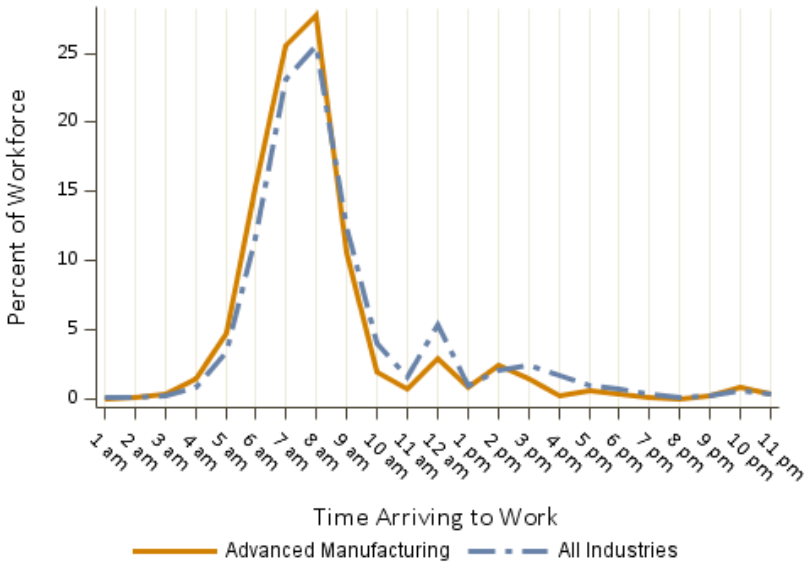


Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, author's calculations

Residency and Commuting Patterns

Most of the region's Advanced Manufacturing workforce (64%) lives and works in the Northeast (Figure 29). While certainly a majority, this is among the lowest in-region residency rates of the seven study regions, exceeded only by the Boston Metrowest region. Nearly 15 percent of the Northeast Advanced Manufacturing Workforce commute in from Boston MetroWest, with another 15 percent opting to live out of state (mostly

Figure 30
Time Arriving to Work

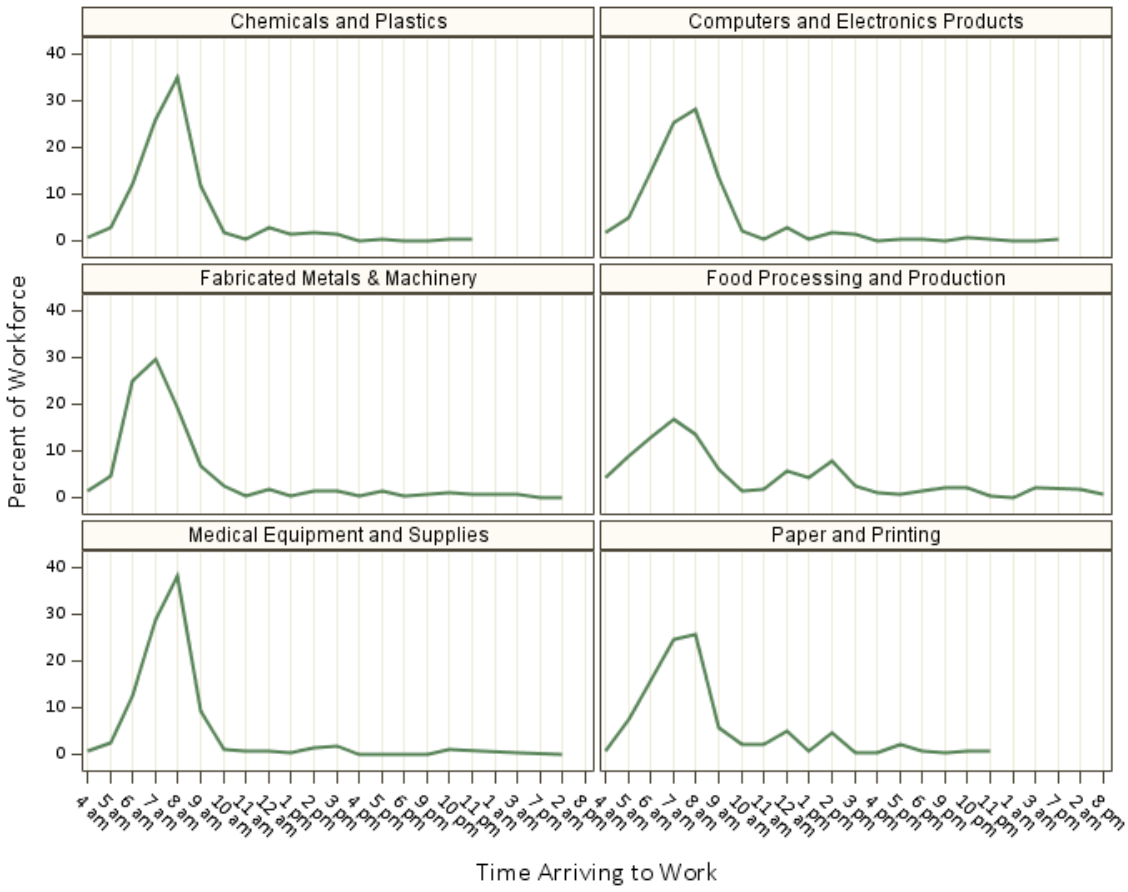


Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, author's calculations

New Hampshire). This is the highest share commuting in from out-of-state among the seven study regions. The typical Advanced Manufacturing employee in the Northeast has a one-way commute of roughly 30 minutes— just two minutes longer than the state average for the sector, but nearly six minutes longer than the average worker in the region.

The typical worker in Advanced Manufacturing enjoys a relatively standard work day, with arrival times peaking between 7:00 and 9:00 am (Figure 30). This basic pattern holds for the subsectors, but with start times for Food Processing and Production and Paper and Printing are a bit more spread throughout the workday as indicative of multiple and overlapping work shifts (Figure 31).

Figure 31
Time Arriving to Work, by Advanced Manufacturing Subsector, Northeast Region



Source: US Census Bureau, American Community Survey Public Use Micro Sample 2008-2012, author's calculations

Appendices

Appendix A

Advanced Manufacturing Subsector Definitions

Chemical & Plastics (incl. Pharmaceuticals)

NAICS	Description
3251	Basic chemical
3252	Resin, synthetic rubber, and artificial synthetic fibers
3253	Pesticide, fertilizer, and other agricultural chemical
3254	Pharmaceutical and medicine
3255	Paint, coating, and adhesive
3256	Soap, cleaning compound, and toilet preparation
3259	Other chemical product and preparation
3261	Plastics product

Fabricated Metal Products & Machinery

NAICS	Description
3321	Forging and stamping
3322	Cutlery and handtool
3323	Architectural and structural metals
3324	Boiler, tank, and shipping container
3325	Hardware
3326	Spring and wire product
3327	Machine shops; turned product; and screw, nut, and bolt
3328	Coating, engraving, heat treating, and allied activities
3329	Other fabricated metal product
3331	Agriculture, construction, and mining machinery
3332	Industrial machinery
3333	Commercial and service industry machinery
3334	Ventilation, heating, air-conditioning, and commercial ref
3335	Metalworking machinery
3336	Engine, turbine, and power transmission equipment
3339	Other general purpose machinery

Computer and Electronic Products

NAICS	Description
3341	Computer and peripheral equipment
3342	Communications equipment
3343	Audio and video equipment
3344	Semiconductor and other electronic component
3345	Navigational, measuring, electromedical, and control instruments
3346	Manufacturing and reproducing magnetic and optical media
3351	Electric lighting equipment

Food Processing and Production

NAICS	Description
3112	Grain and oilseed milling
3113	Sugar and confectionery product
3114	Fruit and vegetable preserving and specialty foods
3115	Dairy product
3116	Animal slaughtering and processing
3117	Seafood product preparation and packaging
3118	Bakeries and tortilla
3119	Other food

Paper and Printing

NAICS	Description
3221	Pulp, paper, and paperboard mills
3222	Converted paper product
3231	Printing and related support activities

Medical Equipment and Supplies

NAICS	Description
3391	Medical equipment and supplies

Appendix B

Regional Boundary Definitions